SCIENTIFIC AMERICAN SUPPLEMENT. No. 1202

Copyright, 1899, by Munn & Co.

Scientific American, established 1845.
Scientific American Supplement. Vol. XLVII. No. 1203. NEW YORK, JANUARY 14, 1899. Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year.

A DESIGN FOR AN ELECTRIC LAUNCH MOTOR.

By CHARLES T. CHILD.

FOR the propulsion of an electric launch a motor must unite elements of efficiency, compactness, and strength to a degree scarcely necessary in any other situation. The design given here is for a motor of unusual simplicity of construction, which can easily be built by an amateur at small cost. It is intended for a boat of about 24 feet over all and 4 feet 6 inches beam, drawing 18 inches, and is capable of propelling such a craft at a speed of 7 miles per hour. Gearing of all sorts has been dispensed with, the motor being adapted for direct attachment to the propeller shaft. While the description below refers primarily to a motor for a craft of this size, dimensions are also given for the construction of motors for smaller launches.

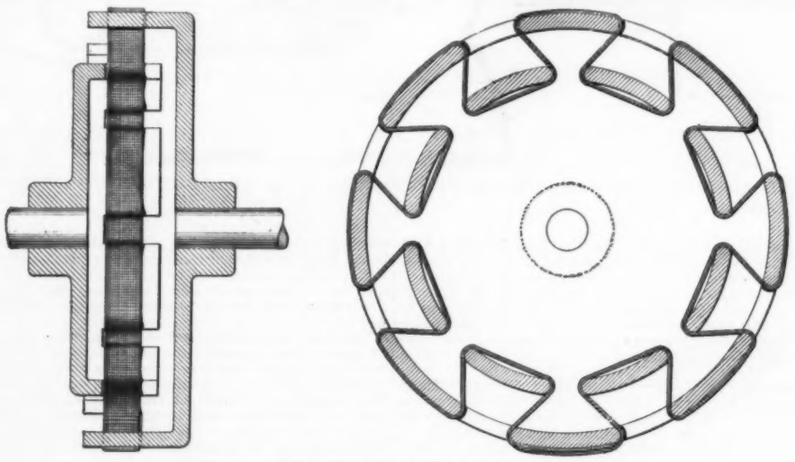
Without going into the details of calculation, it may be stated that for such a boat the most efficient service will be had from a four-bladed screw, about 14 inches in diameter, 12 inches pitch, 35 per cent. blade area (by which is meant with blades having a total projected area equal to 35 per cent. of that of a 14-inch disk), running at 880 revolutions per minute. Such a screw will absorb about 4 horse power. No very definite figures of speeds and powers can be given, as these depend very largely upon the shape of the boat, its fullness fore and aft, the moulding of the runs, etc. The motor described below will give a speed of 7 miles per hour to a rather full-modeled boat of the size indicated, when fully loaded to a displacement of 5,000 pounds. This means, assuming that the boat itself weighs about 1,000 pounds, a carrying capacity for about ten or twelve passengers.

The storage battery consists of 24 elements, arranged in two series of 12 cells each, each cell being of about 80 pounds weight. These cells contain 13 plates each, about 7¾ inches square, and are about 7½ × 8½ inches square by 11 inches in height, these measurements being outside of the rubber containing jars. They should be mounted in two wooden boxes, about 8½ inches wide by 14 inches deep inside and about 7 feet 6 inches long. These make convenient seats in the boat, and their lids may be covered with cushions. They should be placed side by side amidships, as low as possible and a little forward of the center of gravity of the boat to compensate for the weight of the motor, which is installed well aft. Such cells may be bought from any one of several well-known American makers of accumulators. Elements in glass jars should not be used, on account of the danger of breakage.

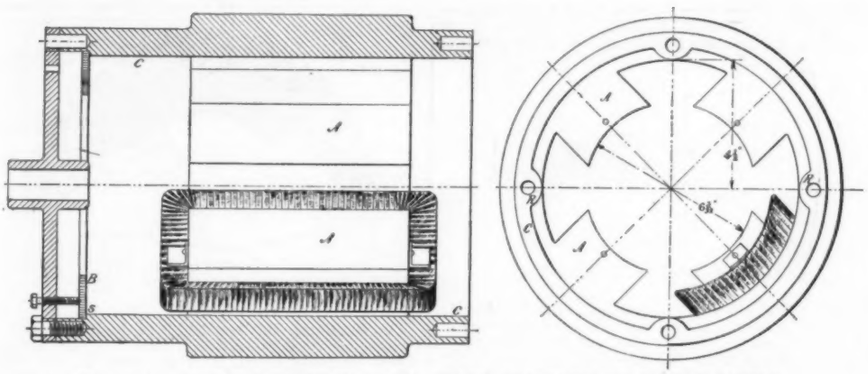
For the smaller sizes of motor described below, or, in other words, for smaller boats of the same general type, the number of cells remains the same, but their size may be proportionately reduced. With cells of the same type, having plates of the size given, a 3 horse power boat will require those having 9 plates and a 2 horse power boat those having 7 plates.

Terminals for charging should be attached to the boxes containing the cells. It is by all odds the best plan to charge the cells in the boat, and not to attempt to remove them for this purpose.

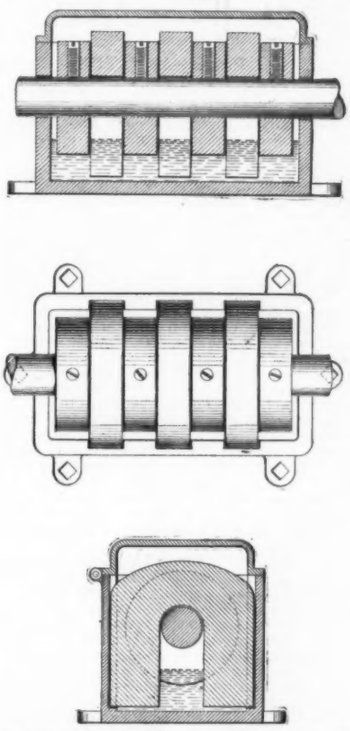
The capacity of these outfits on one charge is about 3 hours' run at full speed, or about 7 hours' run at about 4½ miles per hour, thus giving the boat in each case a cruising radius of about 30 miles. If a larger cruising radius is desired, it may be attained by the



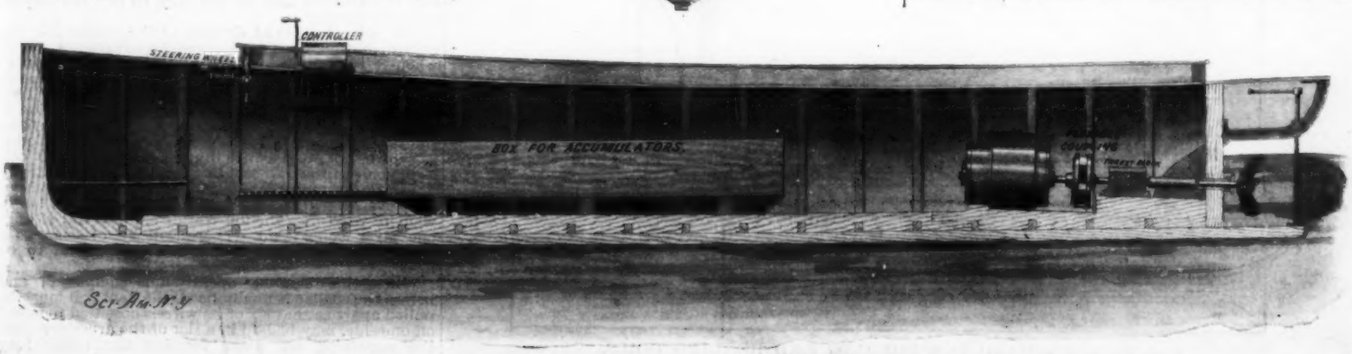
FIGS. 1 AND 2.—SECTIONS OF COUPLING.



FIGS. 6 AND 7.—LONGITUDINAL AND CROSS SECTIONS OF MOTOR SHELL.



FIGS. 3, 4, 5.—ELEVATION, PLAN, AND CROSS SECTION OF THRUST BEARING.



LONGITUDINAL AND TRANSVERSE SECTIONS OF LAUNCH, SHOWING INTERIOR ARRANGEMENTS.

use of larger cells, but, as these are heavier, their use means a corresponding decrease in the passenger carrying capacity of the boat.

The motor illustrated herewith is of a four-pole inclosed type, waterproof and intended to be attached directly to the screw shaft. Some form of flexible coupling is recommended, that shown in Figs. 1 and 2 being very simple and easily made. It consists of two cast iron flanges, the larger about 12 inches in diameter for the motor to be described, and proportionately smaller for the smaller motors. These flanges are mounted, one on the motor shaft and the other on the propeller shaft, so that the smaller runs inside the larger, with a clearance of about 1 inch all round.

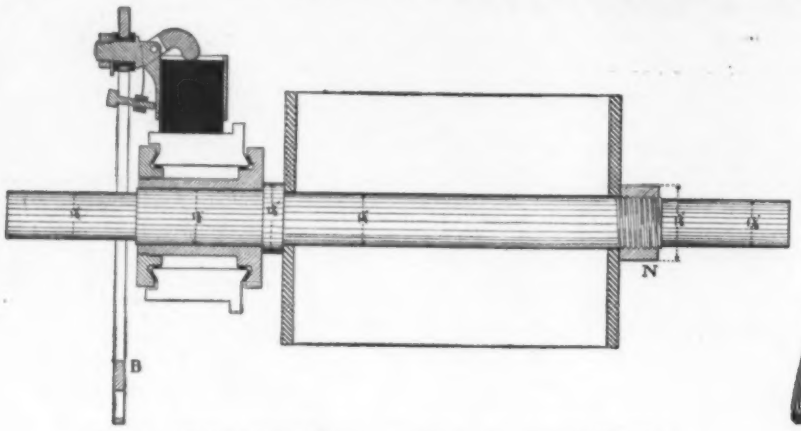


FIG. 8.—ARMATURE CORE, SHAFT, AND COMMUTATOR.

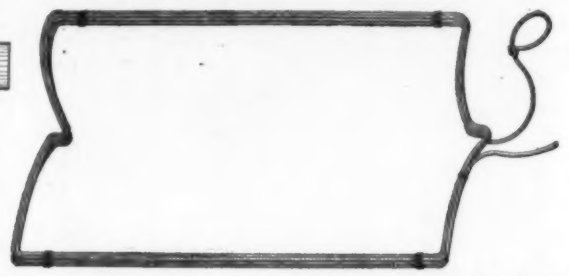


FIG. 13.—COMPLETED COIL, READY TO BE MOUNTED ON ARMATURE.

In the cylindrical surfaces of each are cut eight windows, the edges of which are rounded off as shown in Fig. 2. Through these windows a piece of cotton belting, 1 inch wide, is laced as indicated in the figure, its ends being cemented together. The whole forms an inexpensive and satisfactory coupling, which will largely prevent any strain of the shaft due to the flexure of the boat under loads in a seaway.

A thrust bearing, to take up the forward thrust of the screw shaft, is also necessary. A simple and satisfactory type is illustrated in Figs. 3, 4, and 5. Upon the screw shaft are mounted four steel collars, each about three times the diameter of the shaft and about 1 inch thick. These are provided with set screws. A cast iron box contains the brasses against which these collars work. This box, it must be remembered, receives the whole forward thrust of the screw, and must not only be made strong enough to resist this, but also arranged to communicate the pressure to the frame of the boat. A good plan for mounting it is to place in the bottom of the boat a stout timber, long enough to be screwed to several of the after frames, and arrange the thrust bearing with lugs for four or six lag screws so that it may be securely attached to this. In the size of boat described above, at full speed, the forward push of the screw will be about 230 pounds, but in a sea, or if there is any obstruction in the way, this may be easily doubled.

The box frame of the thrust block, as the illustrations very clearly show, is grooved to receive three horseshoe shaped brasses, each about an inch thick. These straddle the shaft between the collars, which are adjusted to bear equally on the brasses. The box is filled with oil to a level so that the collars run in it, constantly lubricating the bearing surfaces of the collars and brasses. If one of the brasses heats, it may be lifted out and turned around or replaced with another without stopping the boat. A light hinged cover completes the thrust block. For the smaller sizes of motors indicated three collars on the shaft and two brasses will be sufficient.

The shell of the motor, Figs. 6 and 7, is a cylindrical iron casting carrying the four polar projections, *A*. It is shown in the drawings with a perfectly plain exterior, but it should be provided with feet. These are not shown in the drawing, as they should be made to fit the shape of the hull.

At each end of the heavy field ring is a cylindrical projection, *C*, stiffened with four columnar ribs, *R*, to receive the cap screws which fasten on the end plate. The field casting may be finished on the lathe in two operations. It should be chucked and the field bored out to a diameter of exactly 6 1/16 inches. Upon the accurate boring of the field and turning of the armature, or, in other words, upon keeping the air spaces as small as possible, will depend much of the satisfactory performance of the motor.

The end surfaces for the reception of the end plates are trued off at the same time the field is bored, and the seat, *S*, for the brush holder ring, *B*, is also turned. There is no necessity for any finish on the exterior of the field cylinder or any other machine work upon it except drilling and tapping four holes in each end to take the cap screws holding on the end plates. After the field is bored all sharp edges and corners left on the polar projections should be neatly rounded off with a file.

The two end plates are exactly alike, each carrying a bearing 1 1/16 inches in diameter by 3 inches long for the armature shaft. They should be cast of bronze or gun metal, and need not be more than 1/2 inch thick. In the one at the commutator end four windows should be cut, opposite the normal position of the brushes, so that these may be observed while the machine is running.

The brush holder ring, *B*, Figs. 7 and 8, is of brass or bronze, 9 7/8 inches outside diameter and 1/4 inch thick. It carries the four brush holders, one of which is shown

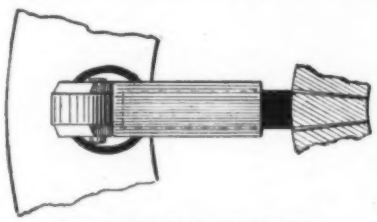


FIG. 9.—BRUSH HOLDER.

in section in Fig. 8 and in elevation in Fig. 9. Any design of radial brush holder may be used, but the simple form shown is easy to make and very satisfactory. The body of it consists of a brass box, cast in one piece with the stud going through the ring, *B*. This is finished out to allow the coppered carbon brush, 1 1/16 × 1 3/4 × 3/8 inches in size, to slide easily through it. A forked piece straddling the upper corner of this box carries a finger which is pressed upon the butt of the brush by the steel spring and thumb screw arrangement shown.

The dimensions of the shaft are clearly indicated in the drawing. The commutator is by far best bought, though the drawing furnishes a sufficient indication of a simple form to enable an amateur to make it himself if he so desire. It has 48 segments and should be 4 inches in diameter, 2 inches face, and bored for a 1 1/4 inch shaft.

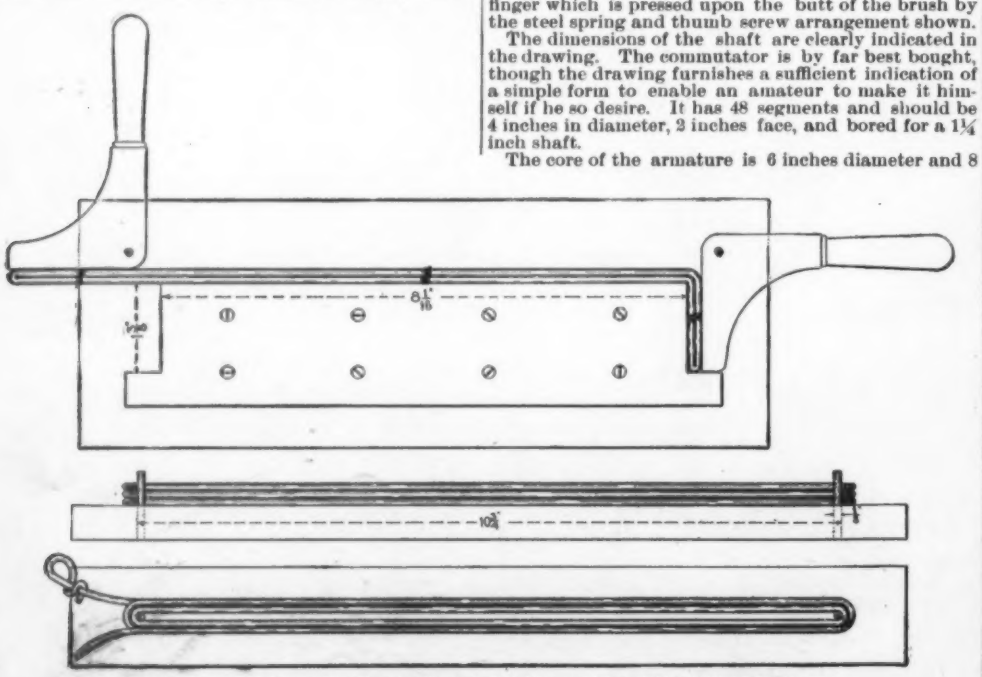
The core of the armature is 6 inches diameter and 8 inches long. The end plates of steel, 1/4 inch thick, hold together the mass of soft iron disks of which it is composed. These should be a little larger than 6 inches diameter in the rough, as the core must finish exactly to this figure. If it comes out a little small, the field bore, which should wait upon the construction of the armature, must be made as nearly as possible 1/16 inch larger.

It is useless to japan or insulate the disks. Put them together as they are, tighten up the nut, *N*, Fig. 8, on the shaft and pin it in place. Then true off the surface in the lathe by very light cuts with a sharp tool at rather high speed, using an abundance of soapy water on the tool. A mirror-like surface may be attained in this way.

While the armature is in the lathe it should be scored for the binding wires which will hold the coils in place. The grooves for these should be turned, each about 1/8 inch wide by a scant 1/16 deep, one near each end and one in the middle.

The next operation is milling out the slots for the winding. There are 48 of these, each 1/4 inch wide and 1/16 inch deep, equidistantly spaced around the core. In milling out armature slots, the tool should turn at a fairly high speed, the feed be very slow and the cut light, and an abundance of oil should be used. If no milling machine is at hand, the slots may be planed, great precaution being taken to keep the cut very light indeed.

The best way to line up the frame of the motor and to be sure that the armature is properly centered in the field bore, is to wrap the armature core with one or two layers of thin paper, until it fits neatly in the field bore, put on the heads at the ends of the machine, and cast Babbitt metal in the bushings. If the end plates are marked so that they can be put back in the same way, the armature will be found to be correctly centered. Unless this is done the electrical balance of the motor will be disturbed, and the brushes will probably spark and give trouble.



FIGS. 10, 11, 12.—BOARD FOR FORMING AND BENDING COILS.

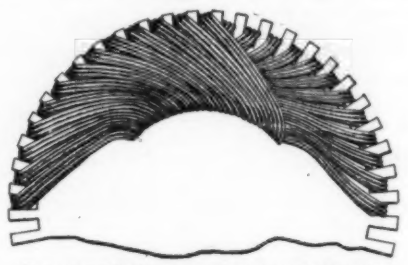


FIG. 14.—END OF CORE, SHOWING ARRANGEMENT OF COILS.

The winding to be described is of the sort known as a four-pole lap winding, and is one of the simplest and easiest to make of the various forms of interlocked windings. Each of the forty-eight coils used is shaped in the forming apparatus shown in Figs. 10, 11 and 12. This is in two parts, a frame for winding the coils and a former for bending them. The frame is simply a piece of board with two 1/8 inch round metal pins driven in it, these being 10 3/4 inches apart, out to out. Around these, as clearly shown in Figs. 11 and 12, is wound six turns of No. 14 B. & S. gage double cotton-covered wire, the starting end of the coil being marked by twisting a loop in it, as shown in Fig. 12. The ends of the wire should be left longer than the illustration shows them, say about 6 inches. When this coil is completed, it should be tied in at least four places with small thread to keep it in position when it is removed from the two pins, and it should be well shellacked with rather thin varnish. It is extremely advisable to make up at least five or six of the boards shown in Figs. 6 and 7, as this enables the winder to allow the coil to dry to the proper consistency of "tackiness" before it is removed from the frame, and also permits the coils to be made much more rapidly than if it were necessary to wait each time for the wire to dry out before winding the next.

The correct state of dryness of the shellac for the next operation must be learned by experience. It is when it is at its stickiest. When this condition is reached, the coil is removed from the frame and placed in the apparatus shown in Fig. 10 to be formed. This machine is made of a wooden base board, on which is screwed a hard wood shaping piece of the dimensions shown and about 1/2 inch thick. Two hinged pieces, as shown, are provided, so that when the straight coil as it comes from the winding board is laid centrally upon the forming piece, and both the hinged pieces bent over, it will be bent into a form somewhat like a wide inverted U. The illustration shows a coil of only one layer being bent. There will be, of course, six wires in each side of the coil, or twelve in all to be bent.

When this bending operation is completed, and before the shellac is finally hard, the bent coil must be pulled apart so that six of its wires, those tied together on one side, may be laid in a slot of the armature, and the remaining six wires, forming the other long

straight side of the bent coil, laid in the slot 90 degrees away. In other words, the coil, when it is put on the armature, must reach from slot 1 to slot 13, assuming that they are consecutively numbered. The appearance of the finished coil, ready to put on the armature, is indicated by Fig. 13.

A glance at Fig. 14, which shows the end of the armature partially wound, will make this clearer. The coils, if properly bent, will lie close together on the

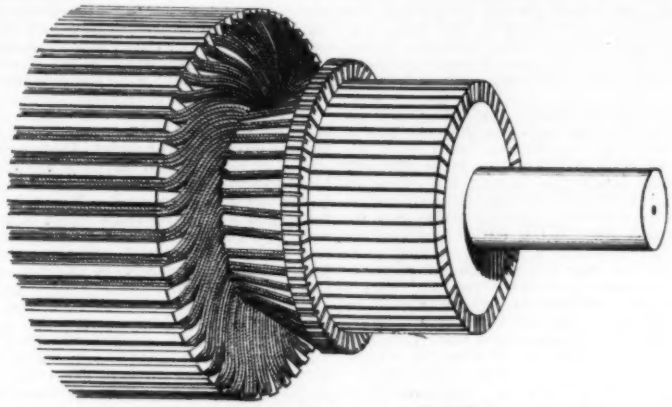


FIG. 15.—END OF COMPLETED ARMATURE, SHOWING COMMUTATOR CONNECTIONS.

heads of the armature and produce the very neat and simple interlocked end arrangement shown in the illustration.

When all the forty-eight coils are in place, the armature is ready for banding. In the shallow scores on the surface are laid thin strips of mica, the armature being in centers on the lathe for this operation, or otherwise mounted so that it can be turned around. It is better to catch the mica strips under a cord wrapped around the core a few turns than to attempt to stick them on with shellac. On the mica is wound the band, consisting of about No. 24 gage German silver or hard brass wire wound under the strongest tension it will stand. The band should not be more than $\frac{3}{16}$ inch wide, the number of turns depending, of course, on the gage of the band wire. Above all, care must be taken not to have this so large or the mica so thick that the bands project above the armature surface, as the clearance space is very small and the bands are liable to injury in putting the armature in place or removing it.

When the band wire is wound on, it is soldered with five or six little dabs of solder, not continuously, and the ends cut off. Three bands will be required, one within about ½ inch of each end of the armature core and the other at the middle.

The commutator is held from turning on the shaft by a feather (not shown in the illustrations), and is sufficiently held endwise by the ninety-six wires soldered into it. To connect these, take the beginning end of any coil, marked by the little loop twisted in it, and solder it and the ending end of the next coil in regular order, either way, into the slot in the tail of the commutator bar nearest in line. Proceed around the armature in this regular order, being very careful to bring the ends out neatly and not to pull the head of the winding to pieces in so doing. No acid should be used as a flux in soldering commutator connections. The only safe thing is rosin. A narrow edged soldering iron that will go into the slot in the commutator bar will be found very convenient for this work. It is well to wind some tape around the inner hub of the commutator before beginning the soldering. When it is finished, a layer of stout cord should be wound on over the bunch of ends going to the commutator to keep these from spreading from centrifugal action when the armature is running. These commutator connections, ready for the cord wrapping, are shown in Fig. 15.

The armature is completed by being returned to the lathe, where a light cut is taken over the commutator to true it and cut off any straggling wire ends. The armature should be baked over night in an oven to thoroughly dry it out before it is attempted to use it in the motor.

On each of the four poles of the field is fastened, with small brass angle pieces, as clearly shown in Figs. 6 and 7, a coil consisting of twenty-five turns of No. 6 B. & S. gage wire, arranged in five layers of five turns each. These coils are wound on a wooden former and taped. Their inner ends should be marked in some convenient way, and they should be connected together so that they magnetize the fields alternately north and south when a current is sent through the four in series. Calling them *A*, *B*, *C*, and *D*, this is done thus: Bring out the outer end of *A* through a hard rubber bushing in the commutator end plate (the end plate at the commutator end of the motor), then connect the inner end of *A* to the inner end of *B*, the outer end of *B* to the outer end of *C*, the inner end of *C* to the inner end of *D*, and bring out the outer end of *D* through another bushing.

Two other bushings are provided for bringing out the ends of the wires to the brushes. The four brushes are connected in two pairs, opposite brushes being connected together and to one of the leading-out wires. These connections should be made with No. 8 wire and the leading-out wires should be No. 6 flexible rubber insulated cable.

Should it be desired to construct motors of this type, but of less power, the same general instructions should be followed, the diameter of the armature and casing being the same, but their lengths different. Below are given dimensions and speeds for motors of two and three horse power; where a dimension is not given, it is the same as that described above for the motor of four horse power. The slots for the three horse power armature should be ¼ inch wide and ⅝ inch deep; for the two horse power armature, ¼ inch wide and $\frac{7}{16}$ inch deep.

The motor now being complete, the next part of the boat's equipment is the controller. The design shown is exceedingly simple and easy to make. Referring to Figs. 16, 17, and 18, which show it in section, and Fig. 19, which is a diagram of its connections, its construction and operation will be readily understood. It has been thought best not to complicate its construction by attempting to combine the ahead and astern controlling movements with those for speeds, so two handles are provided, one giving half and full speeds and the other for reversing the boat's direction. These are, however, for convenience, mounted at the two ends of the cylindrical case of the controller. The best material for this is wood. It should be about 10 or 12 inches in diameter outside, and about 1 inch thick by about 9 or 10 inches long, and is conveniently built up in the way described above for the pattern for the field

Horse Power.	Armature.		Armature Wires per Coil.				Field Coils.			Commutator.	Volts.	Amperes.	Speed.
	Length.	Slots.	Gage.	Wide.	Deep.	Total.	Turns.	Layers.	Gage.	Face.			
	Inches									Inches			
2.....	4½	48	16 B. & S.	4	3	12	40	7	10 B. & S.	1¼	48	35	900
3.....	6⅛	48	15 B. & S.	3	3	9	42	7	8 B. & S.	1¾	48	52	850

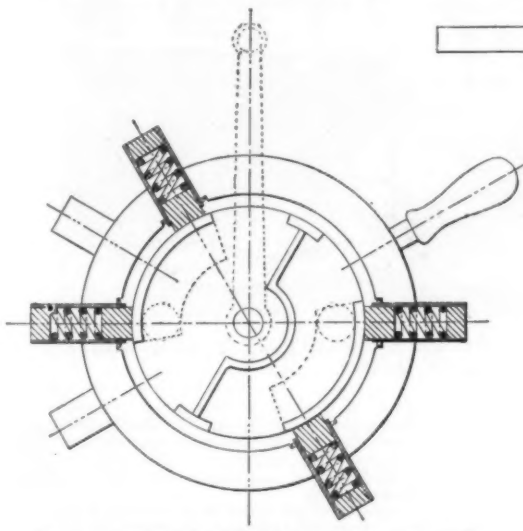


FIG. 16.—CROSS SECTION OF SPEED END OF CONTROLLER.

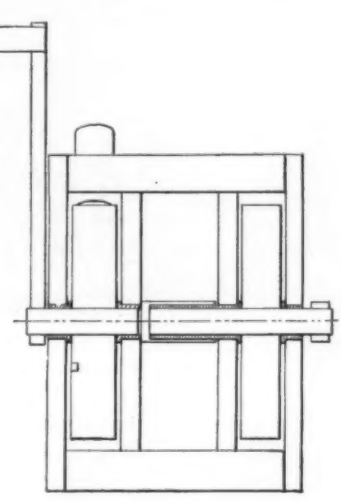


FIG. 17.—LONGITUDINAL CROSS SECTION OF CONTROLLER.

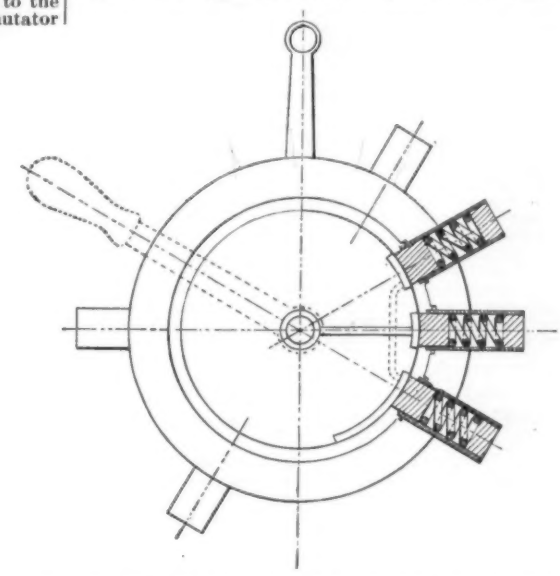


FIG. 18.—CROSS SECTION OF REVERSING END OF CONTROLLER.

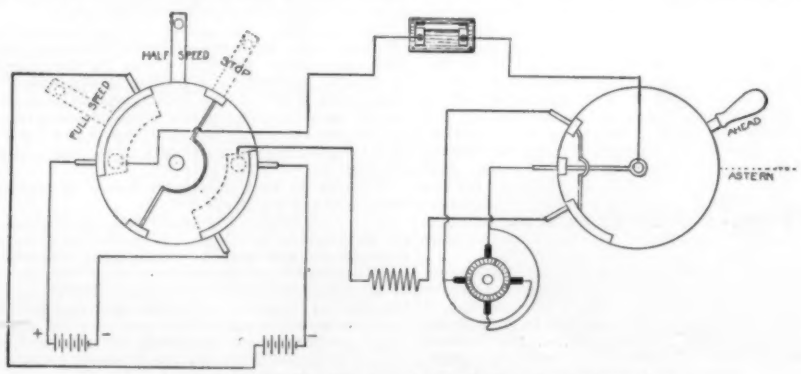


FIG. 19.—DIAGRAM OF CONTROLLER CONNECTIONS.

casting. It should be of wood on account of the insulating properties of that material.

In this wooden cylinder are mounted two wooden disks, about an inch less in diameter than the internal measurement of the containing cylinder. These two disks are turned by the two handles—the speed and direction handles—and carry on their surfaces copper sectors which are set into the wood so as to leave a smooth surface for running under the connecting points. These are well shown in cross section in Fig. 16, which is a partial cross section of the speed controlling end of the apparatus. They consist of brass tubes, about 1 inch in diameter, 4 inches long, and $\frac{1}{16}$ inch thick, containing a spring and a contact piece (brass or copper), fitting the tube neatly and pressed by the spring into contact with the surface of the disk. Nine of them will be required.

At the speed control end of the apparatus the turning disk carries two short sectors on opposite sides, these being connected together as shown, and two longer sectors extending through about 80° of the circumference. These are also folded over on to the back of the disk, as shown by dotted lines in Fig. 9, so that two of the spring contacts may also bear upon this surface. The easiest way to make these sectors is to cut the parts out of $\frac{1}{16}$ inch sheet copper, and mount them on the wood with small countersunk wood screws. The circumferential and flat parts of the sectors last described may well be soldered together after they are in place on the disk. In all cases the sector should be let into the wood so that there will be no shoulder to catch against the spring contact when the disk is turned.

At the speed control end of the apparatus four of the

spring contact tubes are mounted, bearing upon the edge of the disk as shown; the four being in opposite pairs 60° apart. In the interior of the cylindrical case of the controller are two partitions as shown in Fig. 17, the one nearest the speed control disk just described carrying two of the spring contacts bearing on the flat sectors as shown by the dotted lines in Fig. 16. These bear at points on the same diameter connecting two of the edge bearing contacts.

At the other end of the controller is mounted the mechanism for reversing, which is shown in partial section in Fig. 18. This consists also of a disk carrying on its edge three sectors, two of them only long enough to be entirely in contact with the spring contacts as shown, and the other long enough to bridge two of them, about 50°. Three of the spring contacts are mounted bearing on these, 30° apart. The long sector is connected to the further of the two short ones, while the middle sector is connected to the pivot of the disk and thus to the bushing in which it turns. As Fig. 17 shows, this is made quite long, as this contact has to carry large currents. It should not be less than three inches long, the pivot being a piece of one inch shafting.

Referring now to Fig. 19, the operations of the controller will be easily understood. It shows the connections for half speed ahead. The diagram shows the two sides of the controller separated, for the sake of clearness, but it is, of course, understood that they are no further apart than the two ends of the wooden box in which they operate. The fuse shown in the circuit between the pivot of the reversing controller and the inner spring contact is mounted in the middle division of the box, which should have a door for access. It should be an ordinary single-pole porcelain fuse block carrying a fuse blowing at about 75 amperes. For the 3 horse power motor it should blow at 60 amperes, and at 40 amperes for the 2 horse power motor.

The controller box is easiest made of some soft wood, such as white pine. It should be liberally varnished outside and lined inside with asbestos paper, glued or tacked in place. The two disks should be of hard wood. On the exterior of the box should be marked the positions for the various speeds and directions, or, if the constructor feels so disposed, he can mount a position cam and roller on each pivot.

The controller may be placed anywhere in the boat, but preferably where it can be manipulated by the pilot's left hand while he steers with his right. All the wiring between the batteries, motor, and controller should be run with good quality rubber covered wire, No. 4 gage, and preferably in iron armored conduit so that it may not be disturbed by passengers walking on it.

The 24 cells of battery may be conveniently charged from a 110 volt source of supply by the use of a resistance. This should be of about 3 ohms and is conveniently made of iron wire, about No. 14 gage. About 350 feet of it will be required, and this may be conveniently coiled up in loose coils and hung in a frame. It should not be confined, but allowed to have free circulation of air, as it will warm up considerably. The charging current should be about 20 amperes. Full charge is determined either by the voltmeter, which will then read 50·5 volts, or by the "boiling" of the cells. It is a waste of current to attempt to further charge a cell after it begins to "boil."

If the amateur so desires he may make his own cells, but he is likely to have more satisfaction with those he buys. A type of cell probably best adapted for this purpose is described at length in an article on an electric automobile vehicle in the SCIENTIFIC AMERICAN SUPPLEMENT for November 26, 1898 (No. 1195). For the larger size of motor described these cells should be made with plates 8 inches square, 15 lead plates and 16 zinc plates to each cell.

ELECTRICAL AND ENGINEERING WORK IN THE NAVY DURING THE WAR.*

By W. D. WEAVER, Late Chief Engineer of U. S. S. "Glacier."

THE lessons taught by the late war with respect to the employment of electricity aboard men-of-war are few in number, though important in their bearing. The most decisive result was the demonstration of the immense superiority of electricity over steam for the operation of turret training apparatus—a demonstration so decisive, in fact, that the question of the employment of electric power for this purpose is no longer an open one. The society is to be congratulated that one of its members is the inventor of the system whose application has led to this happy result. I refer to Mr. H. Ward Leonard.

Another question which the test of battle has settled definitely is the superiority of electric ammunition hoists, not only in efficiency in working, but in convenience with respect to location and space occupied that will tend to greatly extend the application of electric power on shipboard generally.

Against the great success in the particulars just mentioned must be set the failure of electrical range finding apparatus and of electrical indicating apparatus in general. As to the first mentioned, the enemy gave so few opportunities for its use, and even then so little necessity existed for its employment in view of the leisurely manner in which our vessels could pick up their range, that possibly neglect had something to do in the case.

At any rate, electrical range finding should not be condemned in general because of the failure of a single system. In fact, the weak points in the one in question would seem to be easily overcome by the employment of alternating currents of high frequency and considerable voltage, thereby enabling a drop between indicating points to be obtained by means of inductance which would be in the order of volts instead of possibly millivolts, as where the direct current is used. I will add that an apparatus somewhat answering this description has been proposed by Messrs. Crehore and Squier.

As to other indicating apparatus, it should be borne in mind that electrical apparatus of this nature requires a certain amount of expert care which it is not always possible to obtain aboard ship, while the contrary is the case with the mechanical apparatus that it would displace. If, in anticipation of battle, the latter is thoroughly overhauled, as would be the case, there is more assurance of its efficient working than electrical apparatus under the adverse condition named, notwithstanding the inherent superiority of the latter. This brings up the question of the deficiency aboard ship of necessary electrical skill, which has been made the subject of an official report by the bureau officer in charge of electrical engineering, and will be referred to later on.

The favorable experience with electric power in the important cases just mentioned should accelerate the extension of its application aboard ship, and while unfortunately the present bureaucratic tendency is not in that direction, as will be noted later, I shall nevertheless refer to some other cases distinctly calling for such application.

The one of immediate importance, and which in fact can be considered a crying necessity, is that of electric ventilation. For warship ventilation, both with respect to coal economy and deriving the most efficient results in ventilation itself, the electric fan offers an ideal solution. The modern warship being divided into numerous compartments, each of these can be supplied with its own electric fan or fans, either for isolated ventilation or to supply a system of only such extent as will involve no sacrifice in efficient ventilation. The type of engine now employed with steam ventilators undoubtedly requires anywhere from 75 to 200 pounds, and even more, water per horse power hour. In the case of a large electric plant and with fan motors of the most ordinary efficiency this would be reduced to considerably below 50 pounds, while at the same time the ventilation for a given expenditure of power would be greatly increased in efficiency.

Whether electricity should also be applied to furnace blowers for forced draught is an open question at the present moment, in view of the very infrequent use of such blowers and consequent large idle electric plant normally that would be entailed.

Other employments of electric power, so obvious that their adoption cannot be greatly delayed, are in driving the workshop and ice machines now installed aboard every warship. The engines of the latter are particularly inefficient, aside from their immense inconvenience through the heat given forth. In these cases the application of the electric motor is so simple that it cannot be open to question, and the same remark applies to winches and ash hoists. On the ship of which I was chief engineer there were six of these, which, I estimated, consumed steam at the rate of over 150 pounds per horse power hour, not counting the great condensation in the long lengths of steam supply pipes.

Steam pumps are, as is well known, grossly inefficient in steam consumption, and the same is true to a lesser extent of other auxiliary machinery connected with the propelling engines. While it may be claimed that it would be inadvisable to render the operation of the propelling machinery, particularly in time of battle or during storms, dependent on obtaining power from the electric mains, in reply it may be said that the number of different engines at present employed to run the auxiliary machinery is in itself a great hazard, for the breaking down of almost any one alone would affect the operation of the main propelling machinery.

Among other probable applications of electricity in the future are to anchor hoists and steering gear. The navy has had a somewhat unfortunate experience with the latter, and this, by the way, carries a lesson with it for those interested in introducing new electrical machinery aboard warships. The lesson is that, in every case possible, such machinery should first be tried aboard merchantmen, and all experimental work entirely completed before attempting to secure adoption by the navy. In many cases it would possibly not be a difficult matter to find opportunities for making the trial on coastwise or freight steamers, or on harbor vessels, though sometimes, however, at the expense of those putting the apparatus aboard. Steering gear and anchor hoists now furnish good subjects for the electrical designer, and if previously tested in the manner described, would undoubtedly stand an excellent chance of adoption for use in the navy in the near future.

As I have intimated, it must be reluctantly acknowledged that, notwithstanding the extremely efficient showing which electricity made during the late war, it is apparently at the present moment not in high favor at the Navy Department. The chief of the bureau having charge of electrical matters has recently reported very gloomily concerning the difficulty experienced aboard ship in keeping the generating plant in an efficient state, and the Naval Board of Construction has recently refused to further extend the application of electricity on shipboard, the decision being that the use of electricity has gone far enough for the present.

It is quite probable that this unfortunate decision was arrived at owing to the unfavorable condition referred to concerning efficient operation. Why the operation of an electric plant of the size installed aboard ship should present any considerable difficulty will probably be a puzzle to those here present who are conversant with electrical operation ashore, as it would also to those familiar with merchant ship electric lighting. The clew is given, however, in a remark by the bureau chief as to the difficulty met with in obtaining an efficient operating force, the fault thus lying, it is to be surmised, not with the electrical apparatus, but with the electrical personnel.

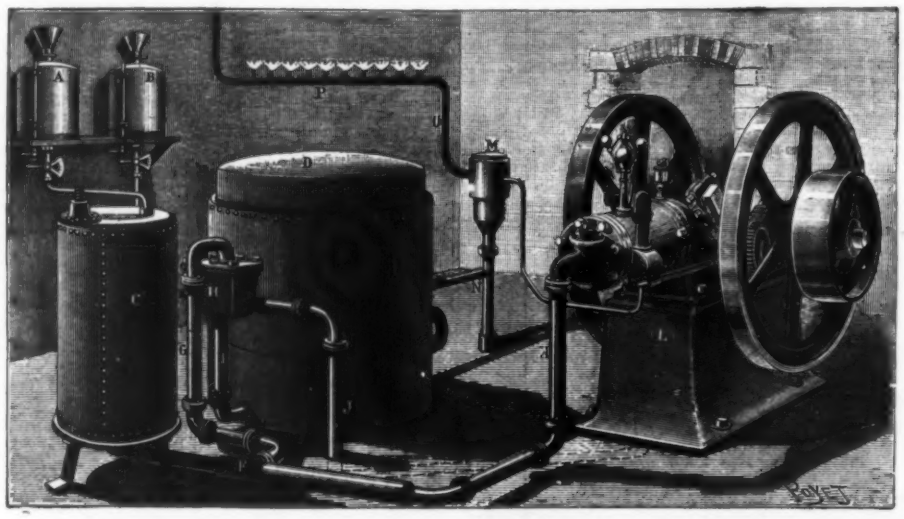
In view of the manner in which professional pride and the electrical industry are thus affected, it would appear entirely appropriate for the electrical fraternity to use its influence to have the appropriate remedy applied to the serious defect which has thus been officially acknowledged to exist. What this remedy should be, might well prove the subject of a departmental, or even of a Congressional, investigation. That it is due to a faulty system, and not chargeable to lack of zeal on the part of the officers affected, can, I believe, be taken for granted.

* Read before the New York Electrical Society, December 14, 1898.

A NEW GASOLINE MOTOR.

THE numerous applications made of the principle of carbureting a gas through the evaporation of volatile hydrocarbons with a view to the production of light and motive power are well known. It is upon this principle that is based the operation of the special gasoline motors that consume from 16 to 18 ounces of gasoline per horse-hour and of the numerous gas apparatus designed for lighting country residences, isolated installations, etc.

The Société Aéro-Petrolique, of Brussels, has recently reduced the consumption of gasoline motors to the figure of nine ounces per horse-hour, and that, too, through the use of any sort of a gas motor in conjunction with a very simple and inexpensive carbureting apparatus. On another hand, an analogous system permits (while leaving disposable the power of the gas motor thus transformed) of utilizing the heat lost in the manufacture of a gasoline gas of which the quantity depends only upon that of the material used and upon the size of the carbureter. The cost of such lighting is, in Belgium, less than a tenth of a cent per burner of ten candles.



APPARATUS FOR LIGHTING THROUGH THE RECARBURETING OF THE WASTE GASES OF A GASOLINE MOTOR.

The principle through which such a saving is effected is as follows. Up to the present, use has been made of air or sometimes of water gas introduced under pressure into the apparatus for volatilizing the gasoline. On another hand, a gas or gasoline motor gives up as a pure loss to the atmosphere the heat of the waste gases, which still contain a notable part of the conbustible gases delivered at the admission. The incomplete combustion of such gases is shown by the formation of deposits of tar and carbon in the discharge. Thus, on the one hand, the carbureting of the supply gas requires a work that is shown by the cooling of the hydrocarburet to be volatilized, and, on the other, a large part of the work disposable, as well as of the heat, is lost in the escapement.

The new system obtains the heat necessary for the first operation from the discharge and brings about the total consumption of the hydrocarburets.

The discharge, instead of taking place in the air, is effected in the carbureter through the play of a valve. The carbureter supplies a gas holder, which mixes oxygen of the air, at a proper temperature, with the carbureted gas. What characterizes the system, then, is the recarbureting of the gases of escapement. The motor gives out only aqueous vapor and carbonic acid, and no condensation of coom or tar takes place in the apparatus.

Thanks to this process, a motor manufactures its supply of gas for itself.

In the accompanying figure, from La Nature, is shown an installation in which the motor is primitively supplied by the gas, and the conduit and escapement have been removed in order to connect it with the carbureter that we are about to describe. The motor preserves its original function as a motor and, in addition, manufactures gasoline gas which may be used with all ordinary burners, and especially in mantle burners, in which this gas, through its richness, gives a particularly favorable rendering.

Referring to the figure, we find at *A* and *B* two reservoirs for gasoline of a density of 0·700. The cylin-

der, *C*, is the first carbureter, which receives gasoline from the reservoir, *A*, and through a special arrangement, reduces it to a vesicular state. At the upper part of the cylinder there is a valve which is capable of opening and giving passage to the external air. This cylinder is connected through a pipe, *F K*, with the motor which we see placed upon the bed, *L*. As soon as the motor is set in operation, a vacuum is formed in the cylinder, with a consequent suction of air into the cylinder, *C*. This air becomes carbureted, enters the motor, is ignited through a burner, and explodes. It will be remarked that the quantity of air carbureted is always limited to the vacuum created in the cylinder. The gases of escapement are afterward forced through the pipes, *J* and *G*, through the regulating valve, *H*, and through the pipe, *I*, into the gasometer, *D*. These gases expand and become cooled. The aqueous vapor condenses and the still hot nitrogen and carbonic acid come into contact with the gasoline of the reservoir, *B*, brought to a vesicular state by a process like that which we have seen in the case of the cylinder, *C*. These gases become enriched, make their exit through the pipe, *N*, enter the pressure regulator, *M*, and, in flowing through the pipe, *O*, supply the burners at *P*. According to the results that have been observed, the gas thus obtained has an illuminating and calorific power much greater than that of coal gas.

At *M* there is branched a small pipe that collects the gas for supplying the burner of the motor. A play of valves upon the holder, *D*, permits of the manufacture of only such gas as is at once utilized. The surplus of the gases of escapement is allowed to flow into the open air.

In order to force out the products of combustion, there is nothing to be overcome except a counterpressure of a few inches of water. The quantity of gas enriched by the carbureter, *D*, depends solely upon the number of cylinders of the motor.

Small motors of feeble power require considerable cooling, to assure which the following arrangements are adopted. The carbureter of the motor is surrounded by a cylindrical jacket filled with water and connected with the cylinder of the motor by two pipes. The water that surrounds the cylinder of the motor becomes heated as a consequence of the explosions, flows through a pipe to the tank, and comes into contact with the sides of the carbureter, which are continually cooled through the evaporation of the gasoline that mixes with the air. The air becomes cooled; reaches the bottom of the tank, passes around the cylinder of the motor and there becomes heated, and so on. With motors of from three to four horse power, 75 gallons of water is sufficient for a run of an entire day. The carbureting apparatus and their accessories in a 6 h. p. motor weigh 440 pounds.

The numerous experiments made in Belgium have shown a consumption of 9 ounces per horse-hour of a gasoline costing about twelve cents a gallon.

When, with a view to the production of motive power, it becomes a question of supplying merely a gas motor in which gas is replaced by gasoline, the carbureting apparatus in a 10 h. p. motor are reduced to two cylinders, the volume of which, relatively to the motor, is that of the single cylinder, *C*, shown in the engraving.

The regulating valve, *H*, allows the waste gases to make their way toward the atmosphere when the reservoir of carbureted gas is full of rich gas. If the valve lowers, the gases of escapement cause a carbureting, and the small cylinder, *C*, enters into play only at the moment at which the motor is set in operation, and when the holder, *H*, is empty.

THE LONGSDON GAS ENGINE.

WE illustrate a gas engine constructed by Messrs. A. & W. Longsdon, of the Waterloo Iron Works, Poole. The general design of the engine is well shown by the illustration, a good feature being that there are no flanges or lugs about the body of the cylinder. Special attention has been paid to accessibility and facility in taking the engine apart for examination or repairs. The valves are grouped together in one box, which has a water jacket in conjunction with that of the cylinder. The arrangement is shown by the section illustrated in Fig. 2, in which *A* is the gas inlet valve, the

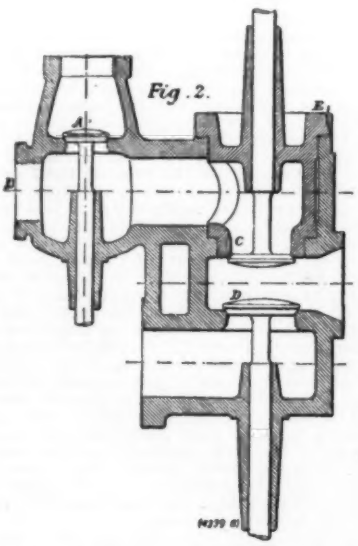
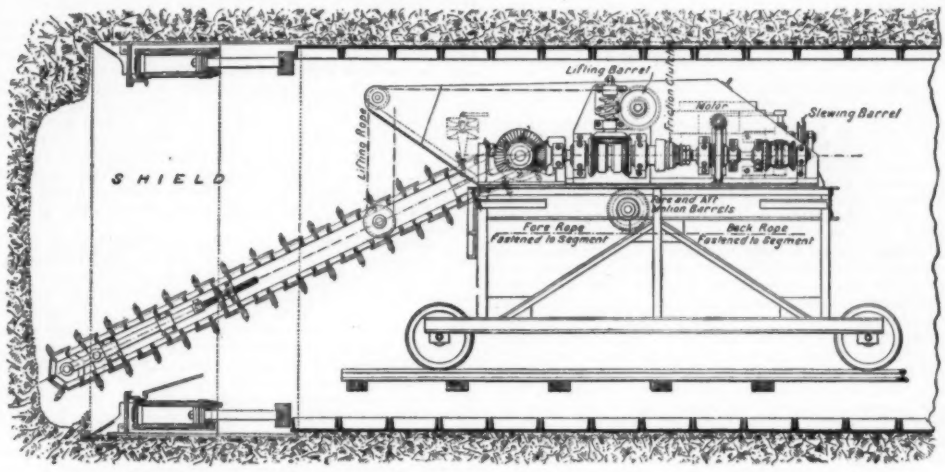


Fig. 2.

air supply opening being shown at *B*, *C* is the admission valve to the cylinder, and *D* is the exhaust valve. The seating of the inlet valve is cast in one with the cover, *E*. This admits of the valves, *C* and *D*, being easily removed. The valves, *A* and *D*, are actuated by levers, these levers being operated by means of cams fixed on a horizontal shaft carried in the bed of the engine and worked by skew gear from the crank shaft, as shown in Fig. 1. These engines develop on the brake three and a half times the nominal horse power. A considerable number have been constructed at the Poole works.—Engineering.

THE CENTRAL LONDON RAILWAY.

WE place before our readers some particulars of the Thompson electric excavator, an ingenious labor-saving contrivance which has been successfully adopted for operating in connection with the shields on the section between the Marble Arch and Newgate Street, the contractors for which are Messrs. Walter Scott & Company. From the illustration a good idea of the size and construction of this machine will be obtained. It was specially designed to suit the clay found on this section of the undertaking, where large bowlders up to 3 feet and 4 feet in diameter were encountered. For one stretch of the contract, from about Berners Street to Red Lion Street, the bottom of the tunnel passes

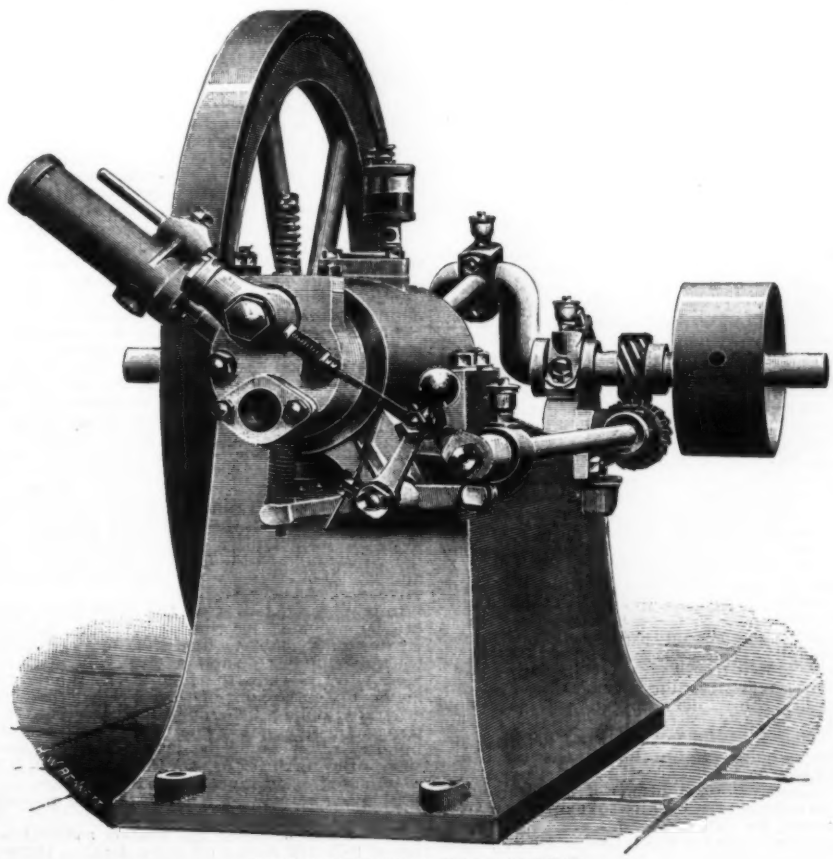


THE THOMPSON ELECTRIC EXCAVATOR, CENTRAL LONDON RAILWAY.

through the London clay into the Reading beds, which consist here of hard red clay, occasionally beds of white sand, and beds of very hard limestone rock. Any machine constructed on the principle of the rotary cutter was out of the question in dealing with such material, and in addition to this it was deemed imperative that the machine should be altogether separate from the shield, so that in the event of meeting water-bearing strata handwork could be resumed at once. The machine consists essentially of a dredger ladder, the working end of which can be moved vertically, horizontally, and longitudinally, each motion being so arranged that a slow, definite feed can be given, and so that a point of the ladder having been moved to any position in the face is rigidly held down. The ladder itself is 17 feet long, and is provided with an extension screw arrangement for keeping the bucket chain tight. The buckets, of which there are thirty-seven, consist of a bottom and back only, the back being fitted with teeth. These teeth are of wrought iron, chisel-pointed, and dropped into recesses cast in the back of the buckets.

About 6 feet from the driving tumbler end of the dredger the ladder is supported by two chains passing to the winding drum. The ladder is attached to the top carriage, which revolves on a king post on an undercarriage. This under carriage is in the nature of a goliath, with an opening 5 feet 8 inches in height and 5 feet in width, sufficient to allow the wagons used in the tunnel to pass underneath. The machine is electrically driven, a 100 ampere motor at 200 volts being placed on the back end of the machine. This drives through worm gearing a shaft placed parallel to the top carriage, which drives in its turn a beveled wheel of the driving tumbler. The slewing, raising, and lowering gearings are each worked through a worm and worm wheel from the longitudinal shaft. The fore-and-aft traveling gear is worked from a pulley on the other end of the motor which drives through the king post by the countershaft and worm gearing. Two barrels are placed one on each side of the under frame. From these barrels wire ropes are led fore and aft of the machine, and fastened to the sides of the tunnel. It will be noticed that each of these traveling, raising, slewing, and fore and-aft motions is worked by means of worm gearing, so that without the use of a brake the point of the ladder is held definitely wherever the feed takes it. A fuse is inserted in the lead of the motor, so that in the event of the dredger meeting any impediment in the face, such as a stone, etc., no damage will result to the machine. A reversing switch is used, by which the motion of the ladder can be reversed if required and pulled out of the face. The lever for working the motions, the reversing switch and the ten-way switch for turning on the current, are brought together within easy reach of the driver, who stands on a small platform at the left-hand side of the machine.

In working the machine, supposing a ring of iron has been put in, the machine is traveled up to the face and excavates all that it can reach for a distance of 18 inches to 2 feet in front of the shield. Part only of the top and part of the sides can be reached by the machine, but the bottom is taken completely out. It was originally intended to clear out this remaining part of earth by hand, but as long as the machine has been working in clay it has never been found necessary to do so, the shield removing the remainder quite easily. Where rock has had to be dealt with, it has been cleared away to the line of cutting edge of the shield. The machine having taken out all it can do, is run


THE LONGSDON GAS ENGINE.

back 10 feet to 12 feet clear of the face. The shield is then pumped forward and the iron lining erected and bolted up. The usual time taken by the navvies for excavating sufficient for a ring in front of the shield is from one and a half to one and three-quarter hours; pushing the shield forward and erecting the iron occupies about the same time. When the machine had been in use for two or three months, the time occupied in pushing the shield and erecting the iron was very much reduced, and during the last few weeks' work of the machine eight rings were put in several times during the two shifts. The average number put in, however, was three 20-inch rings per shift of ten hours. The number of men at the face, including the driver, was usually eight, but was reduced latterly to six. The number of men employed at the same work by hand was fourteen. The machine was constructed by Messrs. Scott & Mountain, engineers, Newcastle, to the designs of Mr. Thomas Thompson, Messrs. Walter Scott & Company's agent on this work.—The Engineer.

THE TACTICAL APPLICABILITY OF THE MAXIM MACHINE-GUN.*

By Lieutenant-General A. v. BOGUSLAWSKI, of the German Army.

TAKING as a basis of speculation an average of the results obtained in war and on the proving-ground, it must be conceded that it is a most dangerous policy, so far as the armament of a force is concerned, to set up a fixed principle, and in the light of this principle to examine new inventions superficially or to reject them entirely. The entire history of war from 1859 to the most recent times proves the truth of my assertion. The memoirs of Generals Lebrun, Du Barail, Fleury, and Trochu, for example, glaringly expose former French criticisms of the needle-gun and its inapplicability to practical uses.

Although we have ever carefully tested new inventions, and have kept abreast of the times in introducing them, periods of delay and decline are noticeable. Such a period was, for example, that from the ending of the Austrian war to the beginning of the French. During this period we thought we would be able to keep up with the latest improvements by making slight changes in the needle-gun. But the fact that with this weapon we had just won great victories must also not be forgotten in explaining this remissness.

For decades after 1871 it was obstinately insisted upon that all weapons should be of the same type; and that only one particular kind of shot (shrapnel) should be used, notwithstanding that the experiences of Plevna showed quite plainly—as I emphatically declared at the time—that for field-operations we needed mortars. Future developments have confirmed this view. We are now going to obtain field-howitzers.

To have types of weapons as nearly as possible alike is undoubtedly of great advantage; but the conditions of war are too various in order firmly to adhere to this principle.

The Maxim gun has now reached a stage of development which demands the most thorough examination of its utility. According to general belief, such an examination will be made by the German government.

The weapon has been introduced in our colonial troops, in our navy, and, if we are rightly informed, in our fortresses.

In several battles fought by our troops in Africa the gun was not particularly serviceable, for often it missed fire. The latest improvements lead us to expect that such accidents will in the future occur but rarely. In the battle of Atbara, Maxim guns were most effective against the Dervish cavalry. The reports which have been received of the recent victory of the British over the fanatic hosts led by the Khalifa at Omdurman, have again proved the effectiveness of the gun. We have here an instance of its efficiency against cavalry attacks in which solid bodies of men were also directly employed. It must, however, not be forgotten that the artillery of the Dervishes appears to have been of no use whatever. In the Spanish-American war, the Maxim gun, it seems, was not used.

Comparatively small bodies of colonial troops can turn this weapon to good account in increasing the efficacy of their fire when opposed by uncivilized tribes. In such cases the gun partly compensates for lack of men. Results thus obtained are, however, of little value so far as European wars are concerned.

The question with which the tactician must concern himself is, whether the peculiar character of the gun permits its use in the field and in forts.

England has answered this question in the affirmative, and has furnished every mobile brigade of infantry and cavalry with Maxim guns. The Swiss have also taken steps in this direction. When used on the battlefield the gun can be considered only as an auxiliary weapon for cavalry and infantry. Every addition of this nature causes the organization to become more complicated. Such complexity is to be avoided so far as possible; for our organization has become intricate enough through the formation of bodies of technical troops.

The machine-gun demands new technical and tactical study on the part of the officer, whose sphere of knowledge and field of activity, compared with former times, have uncommonly increased. One officer, at least, must take charge of the fire of every two or three machine-guns, even though the work of sighting and aiming is done by the gunners. But more than one officer in each battalion or cavalry regiment must be familiar with the use of the gun; for substitutes must always be at hand to take the place of those who have been disabled.

It would seem that the gun can be used with good results by cavalry. Not long ago I heard it said that the addition of mounted artillery would be of little value; that the guns could with difficulty be employed during a fight; that the artillery, only in rare cases, would be enabled to fire with effect, and would often even be captured. That it is difficult to bring artillery into action is generally known; but the obstacles mentioned seem more likely to be encountered in maneuvers than in actual warfare. The conditions of war are so various and the tasks of the cavalry so many-sided that artillery cannot be easily spared. This many-sidedness argues apparently for the introduction of Maxim guns. The theory has been much defended and also practically demonstrated in the Russian and Austrian armies, that cavalry far in advance of an army, regardless of their being armed with carbines, must be supported by a reserve-body of infantry. But it can be argued that a body of infantry would be unable to keep pace with the cavalry. Various remedies have been proposed, among which may be mentioned the transportation of the infantry by wagons, or the use of bicycles. But against these proposals many objections can be opposed. The machine-gun, however, offers a means for providing deploying cavalry with an effective reinforcement.

In the meeting of strong masses of cavalry in an open field, it would be difficult for mounted artillery, in preparing an attack, to take up with sufficient rapidity a position at the side of a wing, or in spaces between brigades and regiments, and if the enemy be already moving forward, to break his formation by their fire. Can this be more rapidly accomplished by machine-guns than by artillery? We believe that it can. The Maxim gun can be mounted upon a four-wheeled field-carriage, upon a light two-wheeled carriage, upon an infantry or cavalry cart, upon a light field-carriage, or it can be packed upon a horse. We consider the use of light carriages and gun-horses the most suitable means for transporting the piece when used by cavalry. Two or three light wagons drawn by two horses each, and containing ammunition, could no doubt bring the machine-guns into position with greater rapidity than a battery. Even though this may not be the case, the machine-guns undoubtedly offer a smaller target than a battery, besides making as good use of their ground as regular artillery.

It would therefore appear that the Maxim gun, at the very moment of the meeting of two cavalry forces, will be found to be an auxiliary weapon by no means to be despised. The Maxim gun in actual warfare can be considered effective up to 1,500 meters. At ranges of 800 meters the effect of the fire is particularly good. Field-artillery undoubtedly surpasses the machine-gun in effectiveness for longer ranges. The moral effect of well timed exploding artillery projectiles is also greater. But, on the other hand, the Maxim gun has the merit of permitting the gunner to move his piece sidewise as well as vertically. It is, therefore, possible to sweep the field with an uninterrupted fire—an advantage against a rapidly approaching line of attacking cavalry. The weakness of artillery when opposed by cavalry is most apparent in such moments and would be partly overcome by the Maxim gun. At the moment in which two cavalry forces meet it would not be endeavored so much to harass the enemy from a great distance by gun-fire, as to destroy him by firing at medium and short ranges, in order either to open the way for an attack or to repel his onslaught. In such cases the Maxim gun can perform the work of an improved *mitrailleuse*.

If the cavalry advance to capture places held by the enemy, the Maxim guns would be of service in opening a way by enfilading the approaches to villages and the outskirts of forests. The chief work must, however, be performed by artillery in preparing for an attack of the dismounted cavalry, of the infantry, or of the bicycle corps.

All the more effective will the Maxim guns prove themselves in holding such places. The proper use of the guns would here probably consist in enfilading the approaches or the regions most favorable to the deployment and to the attack of the enemy and to take their position accordingly. All this demands a quick, tactical eye and knowledge of the weapon's peculiarities.

The use of the gun by infantry appears to us of far more doubtful value than by cavalry. It will always be a questionable procedure to carry along weapons which cannot be used under all conditions. Among the causes which diminish the value of the weapon when used by infantry, is the fact that the Maxim gun, unprotected by some shield, would always present a higher target than a soldier stretched on the ground. At short distances this circumstance is a most weighty consideration. That it would be impossible to shield the gun by digging trenches during the actual attack, is a great obstacle against the use of these weapons by infantry. If, as many hold, an attack in a modern battle is a kind of siege-attack (Belagerungsangriff), then, to be sure, the Maxim gun might possibly be used, but only at long ranges. We believe, however, that this theory will be disproved when the gun is tried in actual warfare. The attack on important points must be well prepared, and must be incessantly followed up.

A further discussion of this particular phase of the subject is not within the province of this essay. The statements made, it must be understood, apply only to decisive attacks. During sham attacks it can, of course, happen that a force, having entrenched itself on the ground captured, may possibly have time enough to provide protection for the machine-guns.

The Maxim gun is incapable of keeping pace with the rapid onward movement of infantry necessary in modern attacks. Though the machine-guns be transported in whatever way we will, in actual battle they can be used only on the lowest possible mount. Whether carriages or portable gun-mounts, which can be easily carried by two men, or sleds will prove most efficient in transporting the piece, exhaustive tests alone can show. If it be taken into consideration how often the fighting of the infantry in 1870–1871 consisted in a wild surging hither and thither, and that in future battles the same surging will occur, our view of the inapplicability of this weapon to infantry attacks will receive more consideration.

In prepared defenses, on the other hand, protection can be provided for the Maxim gun. A number of Maxim guns against a body of infantry, both firing the same number of shots at the same time, would be more effective than the infantry at ranges from 900 meters up, on account of the concentration of the fire, accurate aiming being presupposed. But the question can here be raised whether the fire from individual infantry rifles cannot be more easily corrected than that of the Maxim gun. On the other hand, it is easier to observe the effect of the Maxim gun-fire, and a correction can be made if the battery be properly commanded.

If we are to consider the weapon applicable to the use of infantry acting on the defensive, the questions would still have to be answered:

1. Is it desirable to carry along a weapon which cannot be used under all circumstances?

2. As a weapon of defense, is its fire, compared with that of rapid-firing small arms, so far superior as to justify its introduction?

All this can be ascertained only by carefully recording the effects of the gun-fire and by using machine-guns during the maneuvers.

Moreover, it should be observed that care must be taken to prevent a wasting of the ammunition when firing at long ranges; for, at long distances, the Maxim gun is calculated now and then to mislead infantry into premature firing.

At ranges of 1,200 to 1,500 meters the enemy's artillery will direct their fire at the machine-guns; but their task will not be so easy as was ours when we had to deal with the French *mitrailleuses* in 1870–1871; for the machine-gun presents a far smaller target than the *mitrailleuse*, which was as large as a cannon.

To summarize our statements: It appears to us that Maxim guns are well adapted to the uses of cavalry; but it is doubtful whether they will prove as effective when employed by infantry. But the matter is well worth close consideration.

The question of organization would be presumably best solved by the formation of Maxim gun corps, the members of which would be selected from the troops. Two or three Maxim guns should be assigned to each battalion and regiment of cavalry. Whether these Maxim corps, when going into action, or in cases of necessity, should be combined into larger forces, could likewise be determined during the maneuvers, and would depend upon existing conditions.

* From the Kriegstechnische Zeitschrift.

DAMAGE TO ITALIAN SHIPPING BY GALVANIC ACTION.

AN unusual and interesting case has been recently before the Italian courts. The captain of the port of Leghorn, Cavaliere Alcesti Torrini, was the plaintiff in an action against the owners of certain wooden yachts with coppered bottoms lying in the Darsena part of the harbor of Leghorn to enforce a notice on the owners for the removal of such vessels from that part of the harbor. This notice was made on the grounds that the new warships and other iron and steel vessels lying in that part of the harbor were damaged by galvanic currents set up from the copper bottoms of the wooden yachts, the contact with the steel vessels being due to ropes which were made fast to different buoys in the harbor or basin. The fact of the damage to steel and iron ships having arisen, and of its being due to this cause, was clearly established before the court, and the captain's order for the removal of the wooden yachts with coppered bottoms from the Darsena harbor of Leghorn was consequently confirmed by the court.

Prof. Vivian B. Lewes, in a paper read before the Institute of Naval Architects some years ago, stated that damage to shipping was liable to arise from such a cause, and he also put forward the same theory in his book, "Service Chemistry." The fact of the existence of such a danger must be known to very few ship owners, but it is quite possible that the not infrequent phenomenon of an abnormally rusty bottom of some steel ship might be traced to her having been in galvanic contact with some copper sheathed wooden vessel.

In commenting upon this case The Engineer says that in Italy there is another cause for damage at work, which is not unlikely to manifest itself before long, in so far as several anti-fouling compositions manufactured in Italy rely for their anti-fouling effect solely upon the presence of a very large percentage—30 to 40 per cent.—of metallic copper. Such compositions are applied to the bottoms of a large number of Italian ships, in conjunction with a coat of priming, which is supposed to serve as an insulating medium. However effective powdered copper may be as an anti-fouling medium, our contemporary believes that it cannot be applied with impunity to iron and steel ships. In England anti-fouling paints containing metallic copper are also made, but in no case are they applied to iron or steel ships; they are only used for wooden ships, such as fishing vessels and wooden trawlers, on which they give good results, but manufacturers of composition in this country who supply iron and steel ships have long realized that paints containing metallic copper are absolutely unsuitable for application on steel vessels, a fact on which Prof. Vivian B. Lewes expatiated in his book referred to.

Even if insulated to some extent by a coat of priming paint from the outer surface of the vessel's plates, the presence of 30 to 40 per cent. metallic copper in a paint exposed to the action of salt water must set up a strong galvanic action in the whole structure of the ship, and this cannot fail to exhaust itself on those parts of her structure which are most exposed to corrosion or least protected against it; for instance, the floor plates, tank bearers, tank tops, bunkers, etc., for the galvanic current produced on the outside surface fills the whole metal structure of the ship, and whichever plates are most susceptible to corrosion through exposure or otherwise will be most attacked by it. For reasons of cheapness, paints so manufactured have, during the last year or two, been largely used by Italian ship owners, and have even been applied to several mail and passenger steamers, on which they are undoubtedly a source of great danger to life and property. No doubt Italian ship owners who have indulged in such false economy will, when passing their vessels through their periodical surveys, pay a bitter penalty for their ignorance and parsimonious practices. In the meantime British ship owners should be warned against accepting any anti-fouling paints in Italian ports without a guarantee that they are free from metallic copper.—Iron Age.

The density of the population of London has been doubled since 1857. "It is truly wonderful," says The Lancet, anent London, "that its vast population of 6,291,667, located on only 693 square miles, should have in 1897 so low a death rate as 17·7 per 1,000. This rate is not greater than that of a fairly healthy rural district. England well deserves the name she has received as the birthplace and home of sanitary science and practice."

ENGINEERING NOTES.

A new metal track sign now being used to some extent on the Pennsylvania lines, the Missouri Pacific, and the Wabash Railroad, consists of an angle iron post, set in a section of 8-inch sewer pipe, to which it is secured by braces and a collar on the pipe. The pipe is buried in the ground and filled with concrete or earth well tamped, the bell of the pipe giving a good area for the foundation, so that the post will remain vertical. Sheet iron targets of any desired form or size are riveted to the iron post. These signs are manufactured by the Mathews Woven Wire Fence Company, of Jacksonville, Ill.

The question of the porosity of thin steel plates under heavy hydraulic pressure having been raised (says Engineering), experiments have been carried out at the Washington navy yard with the view of settling the point in a practical way. Pieces of sheet steel of ¼ inch, ⅛ inch, 1/16 inch, and 1/32 inch in thickness were subjected to a water pressure of 6,000 pounds per square inch, and in no case was any percolation found. A ¾-inch rivet joining two ½-inch plates also proved tight under the same pressure. A test was also made to determine the friction of water under high pressure, and, while it was inconclusive, there was no evidence that the friction of water under high pressure was any greater than the friction of water not under pressure.

The use of steel instead of timber as a casing for the big shaft of the Portland Mining Company in the Cripple Creek district may be the beginning of a movement which will do much for the preservation of the forests in the far West. Enormous quantities of timber are used in the mines. The Anaconda of Montana devours 40,000,000 feet of lumber each year, while mountains have been denuded of their forests to meet the needs of the Comstock of Nevada. It may be, too, that the use of steel instead of timber will be found to be economical. All the timber has been cut in the vicinity of the great mines, and its cost is increased by the expense of transportation. That will lessen the difference between the first cost of the two materials. A second consideration is that the steel supports will afford equal strength, while occupying less space, thus lessening the expense for excavation. All the mine owners in Colorado are watching the experiment.—Boston Transcript.

The changes that have taken place in the conditions under which armor plates are manufactured are quite as revolutionary as those that have taken place in any other branch of industry, says The Iron and Coal Trade Review. One of the earliest ironclads, known as "La Gloire," had armor plates 5 feet long by 2 feet wide and 4½ inches thick, which were regarded as a tour de force some thirty-five years ago. In 1862, iron armor plates were rolled at Sheffield of a thickness of 5½ inches In the case of the "Dreadnought" the plates were 14 inches thick, and the "Inflexible" had 24 inches of armor in two thicknesses of 12 inches each, with a layer of wood between. Of late, however, there has been a tendency to reduce the thickness of armor, which has been facilitated by the greater resisting power of that supplied by Krupp, or produced by his special process, so that armor exceeding 9 inches in thickness is now rarely called for.

When we want to express the idea of excessive speed, we frequently use the words "with the speed of the wind." Flying "on the wings of the wind" is a frequently used poetic metaphor, but there are lots of better, for the wind, except in extraordinary storms, really travels no faster than an ordinary express (railroad) train, as we may see by the following table of velocity, compiled from the reports of the French Bureau of Meteorology, by M. Pigeot:

	Meters per minute.	Feet.
"Breath of air"	90	300
Light breeze	210	700
Light wind	360	1200
A breeze	480	1600
Moderate wind	600	2000
Strong breeze	900	2700
Heavy breeze	1080	3600
A gale	1290	4300
Tempestuous	1500	5000
		Miles.
A heavy blow	1740	1
A storm wind	2111	1·10
Hurricane	2400	1.50

So we see that 90 miles an hour is the speed of the most terrific "blows"—a velocity which has been attained (at least in spurts) by some of our crack express engines.—National Druggist.

Ship canal statistics or the growth of commerce on the great canals of the world are treated by the United States Bureau of Statistics as follows: The Suez Canal in 1869, when first opened, showed a net tonnage of 6,576 tons; in 1870 this was 436,609 tons; in 1891 the figures reached 8,698,777 tons, since which time there has been comparatively little change, the figures for 1897 being slightly below those for 1896. The Kaiser Wilhelm Canal, in operation but three years, shows an increase of 50 per cent. in that period, or 1,505,983 tons for the first year and 2,469,795 tons for the fiscal year ending March 1, 1898. The St. Mary's Falls Canal, connecting Lake Superior with the lower lakes, shows a more rapid rate of gain than Suez. In 1881 the freight tonnage through this canal was 1,567,741 tons; in 1885 it was more than 3,000,000 tons; in 1887 over 5,000,000 tons; in 1890 over 9,000,000; in 1894 over 13,000,000, and in 1897 over 18,000,000 tons. The freight tonnage passing through the Detroit River has also increased from 9,000,000 tons in 1873 to 23,000,000 tons in 1896. The Welland Canal shows a slight gain of from 819,934 tons in 1880 to 1,279,987 tons in 1896. On the other hand, the New York State canals show a steady decrease in tonnage since 1880. In 1880 the freight carried to tidewater amounted to 4,067,402 tons; in 1890 this was 3,024,765 tons, and in 1897, 1,878,218 tons. In 1877 the average rate per bushel for wheat from Chicago to New York by lake and canals was 11·24 cents; in 1887 it was 8·5 cents; in 1897, 4·25 cents. In the combination of lake and rail freights, the rates fell from 15·8 cents per bushel in 1877 to 12 cents in 1887, and 7·37 cents in 1897. All-rail freights fell from 20·3 cents per bushel in 1877 to 15·74 cents in 1887, and 12·32 cents in 1897.

MISCELLANEOUS NOTES.

Raised ornamental designs, letters, etc., are produced upon walls, vases, and furniture by forcing plastic clay or cement from the nozzle of a new decorating tool, which has a reservoir for the clay and a screw piston at the rear to force the material through a flexible hose to the nozzle in the hand of the artist.

The Sultan of Turkey has just built at Mecca the biggest house in the world. It is intended for the accommodation of pilgrims, and is capable of sheltering 6,000 persons. The next biggest house in the world is in a suburb of Vienna. It consists of 1,500 rooms, 13 courts and 31 staircases, and accommodates 2,112 tenants. Next come the three Rowton houses in London, with 800, 677 and 500 tenants respectively.

A new abrading material equal to emery in hardness, according to the claims of Mr. Floryanowicz, the Russian inventor, as described in The London Engineer, is made from fire clay. The clay is thoroughly washed, mixed in a pasty mass, dried, and then burned at a temperature of about 2,300° F. The result is a uniformly hard product with a hardness of 8 to 9 on the Mohr scale; this is equal to that of emery. The burned clay is crushed and used for making wheels, etc.

The oldest lighthouse in existence is believed to be that at Corunna, Spain. It was built in the reign of Trajan and reconstructed in 1534. England and France have lighthouses which were built by the Roman conquerors. The famous Cordovan Tower of France, at the mouth of the Gironde, in the Bay of Biscay, was completed in 1611, in the reign of Henry IV. After standing 287 years, it was still considered to be one of the finest lighthouses in the world, although its height has been increased. The famous Pharos of Alexandria antedates both of the above by many years, as it was built 250 B. C., but it is not always considered as a lighthouse.—Boston Herald.

It has been calculated that since the outbreak of the insurrection in Cuba in February, 1895, to January, 1898, Spain has dispatched to Cuba some 20,000 kilos. of preparations of quinine, 400 kilos. of opium, 29,000 kilos of carbolic acid, 1,400 kilos. of corrosive sublimate, 2,370 kilos. of iodoform, 350 kilos. of rhubarb, and 2,530 kilos. of castor oil. In addition to these medicines the army absorbed, figuratively speaking, 16,000 meters of sticking plaster, upward of 60,000 kilos. of cotton wool, and 545,000 meters of gauze for dressings. The cost of the medicinal part of the supplies alone amounted to 3,500,000 of pesetas, nominally equal to $700,000. The medical staff comprised between five and six hundred doctors and about a hundred chemists During the three years fifty doctors and sixteen chemists died, most of them having fallen victims to yellow jack.—Medical Press.

A new use has been found for the Roentgen rays in what may be called palimpsestic application, says The Architect. There is, as our readers know, a dispute about the genuineness of the Droeshout portrait of Shakespeare, which has been often engraved. In Stratford-on-Avon it is believed to be the most authentic of all. It has been proposed to apply a solvent to a small portion of the surface in order to test whether there is not another portrait beneath. But Mr. Edgar Flower, the chairman of the governors of the Shakespeare Memorial, says he has already consulted a picture restorer on the subject, and was informed that the experiment would have to be performed on the face, which would be fatal to the picture. Mr. W. E. Wilson, F.R.S., says he has ascertained by testing an old portrait of Sir Philip Sidney, which is also painted on a wood panel, that by means of the X rays and a fluorescent screen any work which is underneath can be seen without removing the paint. By that method many knotty points about pictures can be cleared up, and the test is worth a trial on the Droeshout portrait.

To determine whether a tree was hewn in winter or in summer is of the greatest importance to buyers of timber, especially as regards building timber, since it is well known that timber cut down in summer represents a lower value than that felled in winter. Timber hewn during the resting period, i. e., between October and April, contains in its cells numerous starch particles which cannot be found in wood cut down in summer. Owing to this presence of starch, the wood is coarse and impenetrable, since the starch closes the pores. For this reason winter-hewn timber is exclusively employed for staves, because, with staves from summer-hewn wood, the contents of the barrels are subject to evaporation through the pores. The starch contained in the winter wood is given a violet color by iodine. Hence, if the timber to be examined is coated with an iodine solution and the surface of the felling side appears yellow, it may be assumed with certainty that the respective tree was cut down in summer. The light yellow lines are the moisture rays, while cells, tissue, and wood fibers simply take on a yellow coloring. In the case of winter-hewn timber the amylaceous rays form much darker, ink-colored, black stripes on the yellow ground.—Allgemeine Tischler Zeitung.

In an article, an abstract of which is given in the Journal of the Society of Chemical Industry, E. Sorel finds, in place of roasting the copper, or treating it with nitrous or sulphurous compounds before exposure to the action of sulphuric acid, that the addition of a small quantity of such organic bodies as oxalic acid, alkali oxalates, lactic acid, alkali lactates, tartaric, malic, or citric acid, the corresponding salts, or crude glycerin, facilitates the action of the reagent, without the added substance being itself decomposed or consumed. He proposes to apply this method in practice by charging a vertical vessel with copper turnings, which are then exposed to the action of a continual stream of dilute (1 : 3) sulphuric acid, containing a few grammes per liter of one of the organic substances cited, and kept at 75° to 80° C. by steam heat. Provision is made for the passage of a current of air through the apparatus. This results in the copper being rapidly attacked, and the solution, which drains off through the false bottom of the apparatus into a settling tank, is returned for use over and over again until saturated, whereupon it is cooled and the copper sulphate crystallized out. The copper and acid are renewed as required and the washing water is utilized to dilute the latter. The crystals of copper sulphate obtained are very small, and of a high degree of purity.

SELECTED FORMULÆ.

English Carriage Greases.—The following recipes and directions for making the ordinary kinds of carriage grease are up to date, according to Oils, Colors, and Drysalteries, from which we copy them:

1.	Purified tallow	60 or 80 pounds.
	Palm oil	120 or 200 "
	Water	80 to 100 "
	Soda	10 to 15 "

Having melted the tallow in an iron kettle and heated it to 120° C., stir in the palm oil. Then pour in the soda (dissolved in the water) very slowly in a thin stream, stirring constantly the while. As soon as the soda is all in, the kettle is removed from the fire, and its contents are stirred until they begin to set. The consistency of the product can be regulated by varying the proportions of oil and tallow. The more of the latter, the more stiffness will the resulting lubricant have, and the more palm oil the grease contains, the softer and more easily fusible it will be.

2.	Tallow	17 pounds.
	Palm oil	42 "
	Soda lye (20° B.)	13 "
	Water	184 "

These two fats are melted together in an iron vessel, with constant stirring. Then add the lye, and last of all the water, making a perfect mixture by stirring.

3.	Palm oil	40 pounds.
	Train oil	200 "
	India rubber	4 "
	Litharge	4 "
	Sugar of lead	4 "

The India rubber is cut up very small and heated with the train oil to 195-200° C. in an iron vessel. The contents of the vessel are then filtered, and then again heated with the lead compounds to 200° C. This temperature should be reached in one hour. The palm oil is then carefully stirred in.

4.	Tallow	300 pounds.
	Pig's fat	75 "
	Palm oil	75 "
	Graphite	18 "

This graphite grease is made by mixing the ingredients carefully in a vessel heated by steam.

5.	Paraffin wax	30 pounds.
	Purified rape oil	270 "

The two oils are heated separately and then mixed. The mixture is carefully stirred for a long time. If the grease is for winter use, the proportions given above must be altered and less paraffin taken. It should then only form 6 per cent. of the whole, instead of 10.

6.	Asphalt	100 pounds.
	Black pitch	25 "
	Petroleum	25 "
	Litharge	25 "
	Water	250 "

The asphalt and pitch having been melted together in an iron kettle, the petroleum is carefully added in a thin stream until the contents of the kettle have become uniformly fluid. The litharge is now added and then the water is stirred in. The fluidity of the compound can be varied by altering the amount of petroleum in it.

7.	Asphalt	40 pounds.
	Ship's pitch	10 "
	Litharge	10 "
	Water	80 to 100 "

The asphalt and pitch are first melted together over a gentle fire. The litharge and water are then added, and the whole boiled up with constant stirring all the time. As soon as the stuff has become a fatty mass, the kettle is taken from the fire.

ENGLISH PALM OIL CARRIAGE GREASE.

8.	Red American resin	200 pounds.
	Palm oil	13 "
	Rectified resin oil	37 "
	Soda lye (22° B.)	49 "
	Water	8 "

Having melted the resin, saponify it by adding the water and lye. Then stir in the oils and stir unceasingly till the mass is perfectly homogeneous.

COLORED CARRIAGE GREASES.

1. White.

Rain or other soft water	100 pounds.
Calcined soda	14 "
Sifted slaked lime	30 "
Resin oil	300 "
Train oil	30 "

Dissolve the soda in the water in an iron vessel. Then add eleven pounds of the lime and boil well up. Then stir in seventy-five pounds of the resin oil and boil fifteen minutes, with constant stirring. When the mixture is quite cold, and not before, the rest of the oils and the lime is added, and the whole is stirred till perfectly mixed. The lime is first mixed separately with the train oil.

2. Black.

Rain or soft water	256 pounds.
Calcined soda	32 "
Sifted slaked lime	184 "
Resin oil	192 "
Soot	2 "
Wood tar oil	100 "
Coal tar oil	150 "
Heavy resin oil	600 "
Light resin oil	100 "
Train oil	240 "

Divide the lime into two parts, one of twenty-four pounds, the other of one hundred and sixty pounds. Add the smaller weight to the water, soda, and resin oil. Then add the soot and the tar oils. Add the other resin oils next, mix again, and finally add the train oil and the rest of the lime first mixed separately.

3. Black.

Finest levigated graphite	90 pounds.
Soft soap	60 "
Pig's fat	360 "

Mix thoroughly.

(To be continued.)

THE SAINT GOBAIN PLATE GLASS MANUFACTORY.

VENETIAN plate glass does not merit its reputation. Venetian workmen never produced anything but window glass, and their mirrors, which were marvels without rivals in the sixteenth and seventeenth centuries, are, at the best, good for nothing but reflecting the shaggy faces of antiquarians. Venice was another China. Although the industry was precocious there, it remained stationary. When Colbert, in 1665, undertook to introduce the manufacture of mirror glass into France, he was obliged to corrupt some mirror makers of Murano, in order to attract them to the Faubourg Saint Antoine. But when, eight years afterward, Count d'Avaux, ambassador to the republic of Venice, transmitted to the grand minister of Louis XIV. an offer of new manufacturing secrets, the minister was able to answer: "Our plate glass is now more perfect than that of Venice." In 1688, while glass was still blown at Murano, as it was in the fourteenth century, Louis Lucas de Nehou, a Norman gentleman, and Abraham Thevart, a bourgeois of Paris, simultaneously invented the method of casting plate glass. To the invention of cast glass, which rapidly ruined the rudimentary industry of Venice, was almost immediately attached the name of Saint Gobain.

It was in 1693 that the Thevart Company, which had just negotiated with Louis Lucas de Nehou, installed its factory upon the site of the old castle of Saint Gobain, near Fere. In the seventh century the country had been evangelized by an Irish monk, of royal race, named Gobain, whom King Clotaire came to venerate, and who died a martyr along about the year 660. In the tenth century the castle belonged to the Bishop of Laon; in the eleventh, to the house of Coucy; in the fifteenth, to the Duke of Orleans; and in the sixteenth, to the Bourbons. On July 1, 1692, it was rented at £24 per annum, by Count de Longueval, governor of Fere, to the Abraham Thevart Company. Finally, on July 16, 1698, it was purchased by this company for £3,000.

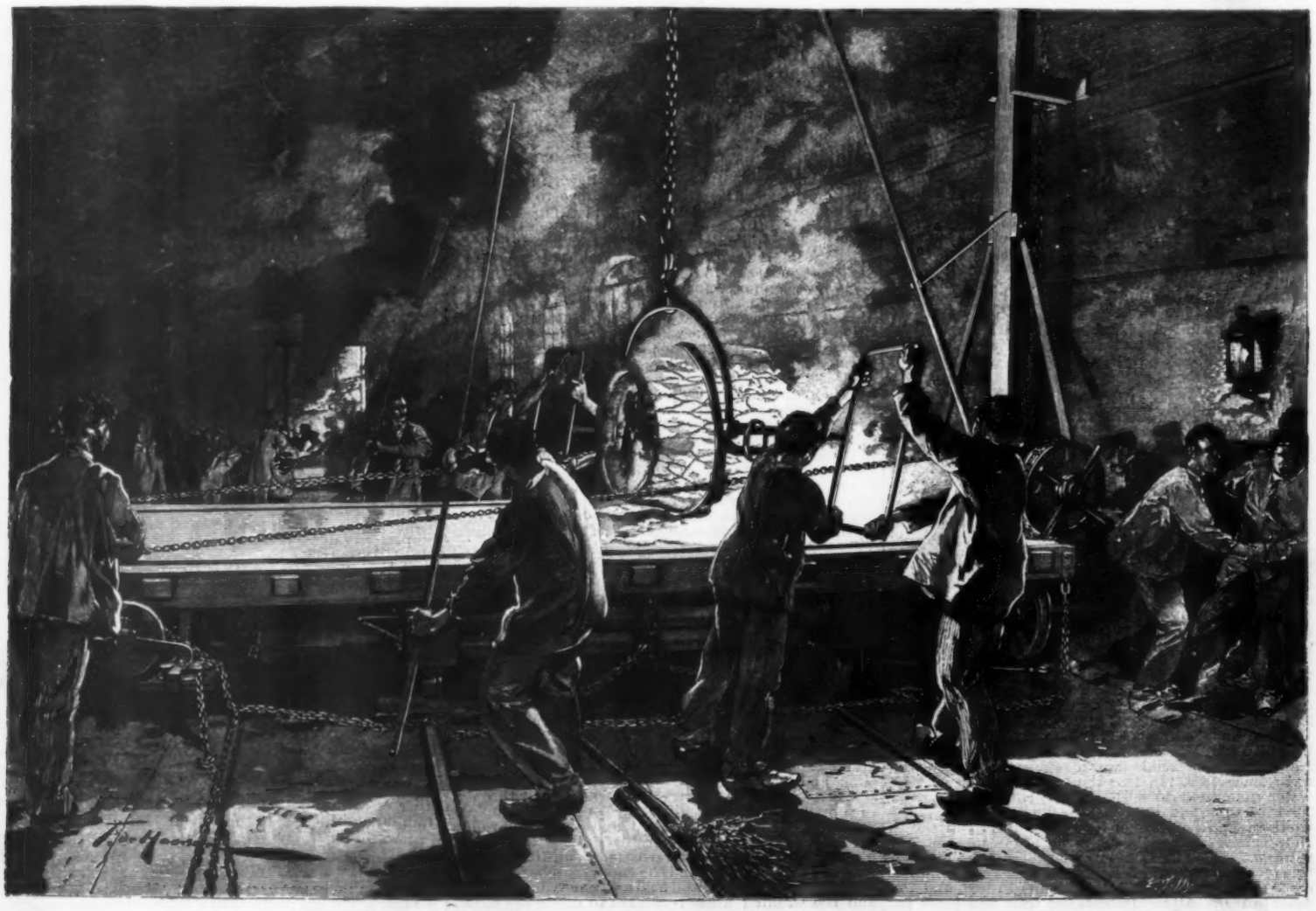
In 1692, Saint Gobain was nothing but ruins, but these ruins were located in proximity to a wonderful forest, that is to say, where fuel was abundant. Thevart, Nehou, and their associates had been attracted by the proximity of the woods and of the river Oise descending to Paris.

Where had stood the towers and been located the moats of the lords of Coucy, they erected several buildings, "not only for manufacturing purposes, but also for the lodgings of the gentlemen, clerks, and operatives;" and, among other favors and privileges, they, in February, 1693, obtained, by letters patent, those of placing at the gate of the establishment a porter in royal livery, the arms of France and the title of "manufacture royale des grandes glaces." This title has become simply "manufacture des glaces" and the arms have disappeared, but the monumental gate of Saint Gobain, designed by Soufflot and flanked by a chapel, has, along with the porter, remained.

The present company (the heir of the companies that obtained the royal privileges of 1665–1703, and which counted among their associates some relatives of Moliere and Racine), the Compagnie de Saint Gobain, Chauny et Cirey, which long ago absorbed all its competitors, owns several manufactories of plate glass, not only in France, but in Germany and Italy. At Cirey it employs 628 workmen and at Stolberg 842.

LOADING CARS WITH LARGE PLATES.

It is at Saint Gobain that its personnel is smallest, the total being 375 workmen and other employes. Here it does not even finish the glass, but sends it for polishing and silvering to Chauny; and yet, to the public, it is the Saint Gobain Company only, and Saint Gobain is its entire prestige. But the old factory of Louis Lucas de Nehou, the Saint Gobain manufactory, properly so called, under the direction of M. J. Henrivaux since 1884, owes its persistent reputation to the fact

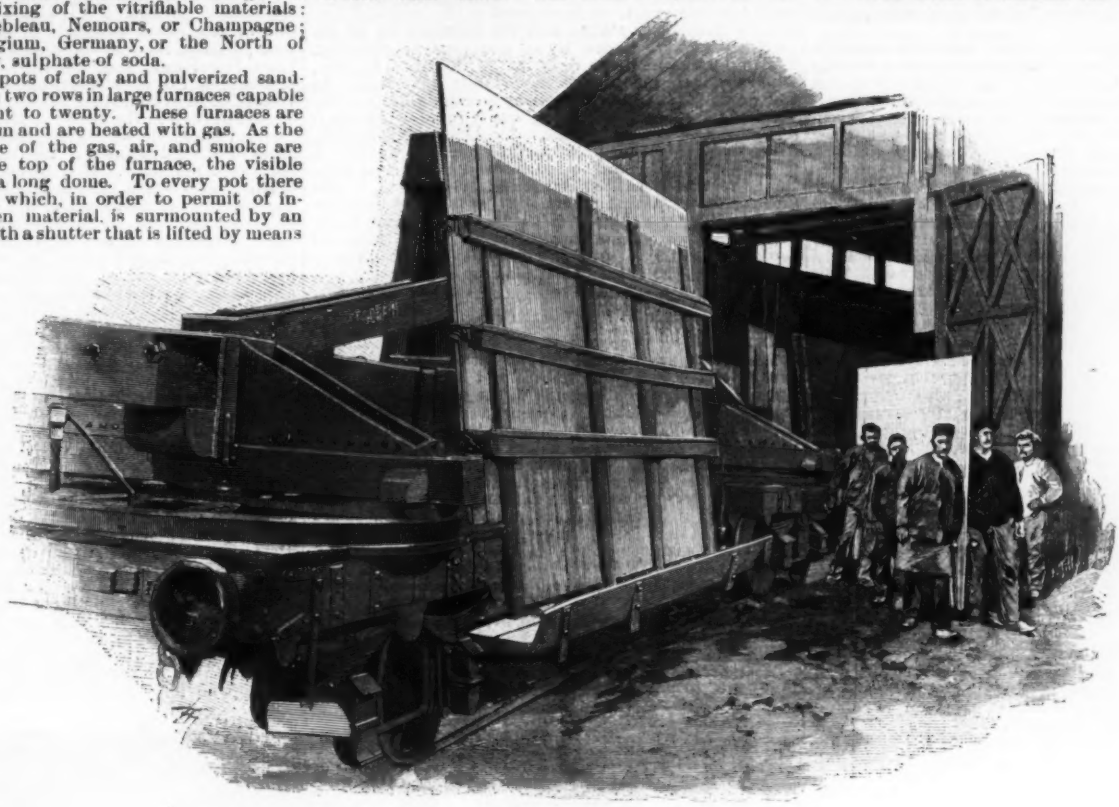


CASTING PLATE GLASS AT THE SAINT GOBAIN MANUFACTORY.

that, although it sends out no finished glass, the product that it prepares is admirable and incomparable.

The first operation in the manufacture of the glass is the braying and mixing of the vitrifiable materials: sand from Fontainebleau, Nemours, or Champagne; limestone from Belgium, Germany, or the North of France; and, finally, sulphate of soda.

The crucibles or pots of clay and pulverized sandstone are arranged in two rows in large furnaces capable of holding from eight to twenty. These furnaces are of the Siemens system and are heated with gas. As the entrance and escape of the gas, air, and smoke are effected through the top of the furnace, the visible masonry consists of a long dome. To every pot there corresponds a door, which, in order to permit of inspection of the molten material, is surmounted by an aperture provided with a shutter that is lifted by means of chains.

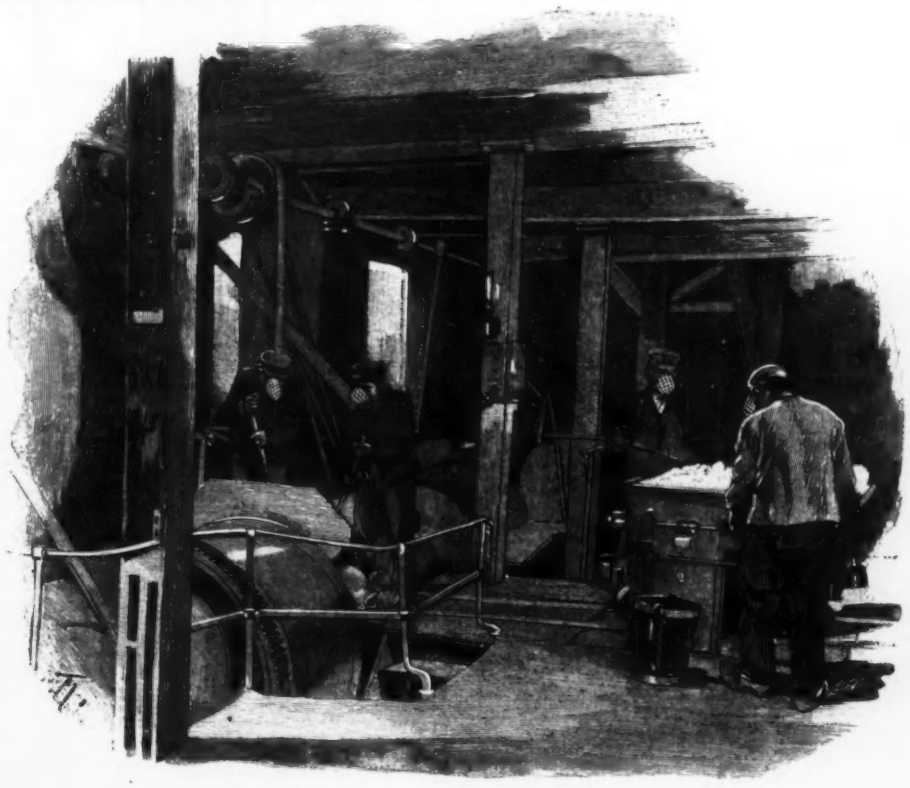


THE CARRIAGE OF LARGE PLATES OF GLASS.

After the furnace has reached the proper temperature, there is thrown into the pots, by means of special shovels, some cullet or broken glass, in order to facilitate the fusion, and then, by successive operations, the vitrifiable mixture is introduced.

After the materials are completely melted (a fact that is ascertained by taking a little glass from the mass by means of an iron rod), after the fining is perfect, that is to say, after the glass has become homogeneous and all the bubbles formed therein have been expelled; and, finally, after the temperature has been lowered until the glass has reached the necessary pasty consistency, the hour for casting is struck.

Under the vast halls of Saint Gobain there does not prevail that feverish and continuous activity that we find in the manufactories of bottle, window, and crystal glass; but, at regular intervals, we here witness a spectacle that is truly grand. The furnaces are opened and the "devil" is brought to the front. This consists of a pair of wheels and a long tongue provided with huge jaws. These latter enter the glowing furnace, seize the incandescent pot, bring it to the exterior, and deposit it, all crackled and apparently ready to burst, upon a flat carriage provided with three small wheels. This carriage and a big crane are then observed to advance toward each other. The crane is provided with special clamps that immediately grasp the pot and lift it. The globe of fire suspended from the arm of the crane seems to hesitate for a moment, and then



BRAYING AND MIXING THE VITRIFIABLE MATERIALS.

A LADLE FOR THE MOLTEN GLASS.

moves toward the casting table, which is sprinkled with fine sand and placed, with its roller, in front of the gaping jaws of the annealing furnace. The pot descends slightly and then tilts. All these motions are regulated with infallible precision, and in every operation there is something solemn.

When, at a signal, the pot is finally turned over, there is almost a surprise. The great stream that escapes from it is appalling only by the reflection. Its color is of a warm opal. The transparent liquid seems unctuous. It spreads over the table, while the huge roller maneuvered mechanically by means of chains passes from one end to the other in order to extend the mass uniformly.

A pastry-cook rolling his dough in order to flatten it does not perform the operation with greater ease. If a lump forms, a watcher, with his eyes fixed intently upon the fiery mass, removes it with a quick and bold hand.

The width and thickness of the glass are regulated by the spacing and height of the iron bars upon which the roller rests.

There is no stoppage in the work. Scarcely has the roller passed over the glass, when the sheet is quickly shoved into the annealing furnace, to remain therein for several days, in order that it may cool slowly and progressively.

In the last century the director of the works often presided over the casting, the tricorne upon his per-

ruque and a sword at his side. This ceremonial has been dispensed with, but the casting of large sheets of glass, although now done more simply, is none the less one of the finest and greatest industrial operations that one could witness.

After the plate of glass has been carefully removed from the annealing furnace, it is placed upon a rocking table made of wood that, upon rising, deposits it upon a slightly inclined frame mounted upon wheels and moving upon rails. This is run into a room which is especially equipped for the handling of plate glass. Here long belts run around pulleys carried by small cars that move upon an overhead railway. These belts permit of lifting and moving the plates in order that they may be carefully inspected. If any defects are detected, the plates are laid upon a horizontal table, and if occasion requires it, are cut into smaller sizes. If the defects are insignificant, the plate is left entire, and is merely squared with a diamond or by means of small steel rollers. Then the table is righted, the belts take the plate and carry it to the door of the storehouse and place it upon another frame, which is this time installed upon a genuine car. A special mode of packing permits of superposing several plates upon each face of the frame, and an iron railway nine miles in length carries them to Chauny, where they arrive rough and opaque in order to be smoothed, polished, and finally silvered.

The carriage of large plates of glass by hand is thus, to as great a degree as possible, avoided. Sometimes, however, this has to be done, and on such occasions the spectacle of a large plate from 150 to 200 square feet in area and half an inch in thickness carried by gangs of six, eight, or ten men by means of straps is exceedingly striking to the visitor. The glass undulates and bends like a sheet of iron. The least abruptness in the stepping of the carriers would endanger the equilibrium. A broken plate of glass is of small consequence, but the wounds caused by slivers of the shattered material are always of a grave nature.

Saint Gobain sent several colossal plates of glass to the Exposition of 1889. One of these measured 26¼ × 13¾ feet, and was obtained from a single pot containing 3,520 pounds of glass. Such a feat has not since been performed.

In the shops of Saint Gobain, alongside of the large smooth tables used for the casting of plate glass, are seen other and smaller ones the surface of which is provided with designs engraved therein. Some of these tables are smooth, and in this case the design is engraved upon the roller. These designs are flutings, lozenges, vermiculate work, arborizations, etc. In fact, to the plate glass industry Saint Gobain has added that of cast glass in relief, which is used for partitions, doors, and windows, and for various purposes in schools, offices, stores, markets, conservatories, etc. For such manufacture the glass is taken from special furnaces (having no pots) by means of copper or cast steel ladles. The casting is done as with the plate glass, but upon the small figured tables that we have just mentioned.

For the above details and the engravings we are indebted to L'Illustration.

ACETYLENE FOR GAS ENGINES.

MR. F. GROVER, A.M. Inst. C.E., of Greek Street Chambers, Leeds, has recently published a pamphlet giving the results of a number of experiments which he has made on the pressures and explosive efficiency of mixtures of acetylene and air. The object of these researches was to determine whether this gas was well adapted for use as the working agent in gas or other explosion engines. The apparatus used consisted of a generator and of an explosion chamber of cast iron, in which the acetylene was mixed with varying portions of air, and the charge exploded electrically. A Crosby indicator was used to record the pressure produced on explosion, which it did by tracing a diagram on a drum which could be rotated at a definite speed. The device for attaining this speed was very ingenious, and deserves special attention. An ordinary center second watch was fixed on a small spurwheel driven by the registering drum. The direction of the rotation of this wheel was in the opposite direction to the hands of the watch, and the speed was so adjusted that the center second hand remained stationary, the watch as a whole being rotated backward by the wheel as rapidly as the center second hand was moved forward by the mechanism of the watch. The initial experiments were made with the mixture at atmospheric pressure at the moment of firing. The weakest mixture which could be fired in these conditions was 1 of gas to 18 of air. The pressures reached were about three times as great as when similar mixtures of coal gas and air were substituted. The rate of inflammation was also much more rapid. The maximum pressure was also obtained with a mixture of 7 of air to 1 of acetylene, and was about 111 lb. per square inch. The experiments were next repeated with the charge at a pressure of 2 atmospheres before explosion. In this case the highest pressures were attained with a mixture of about 11 to 1, the maximum being about 197 lb. Finally the pressure, before explosion, was raised to 3 atmospheres, and here explosion pressures of about 350 lb. per square inch were recorded with a mixture of 11 to 1. With richer mixtures, higher pressures would probably have been attained; but the strength of the apparatus made it imprudent to test this. With an initial pressure of 3 atmospheres it was found that mixtures as poor as 30 to 1 could be exploded, the maximum pressure being then 180 lb. per square inch. Mr. Grover concludes that, from a thermodynamic point of view, acetylene offers great advantages for use in gas engines, though at present prices he states the cost would be prohibitive, save in very special cases, amounting, he estimates, to 5·2 cents per horse power hour.—Engineering.

IMPROVEMENTS IN BRONZE CASTING.

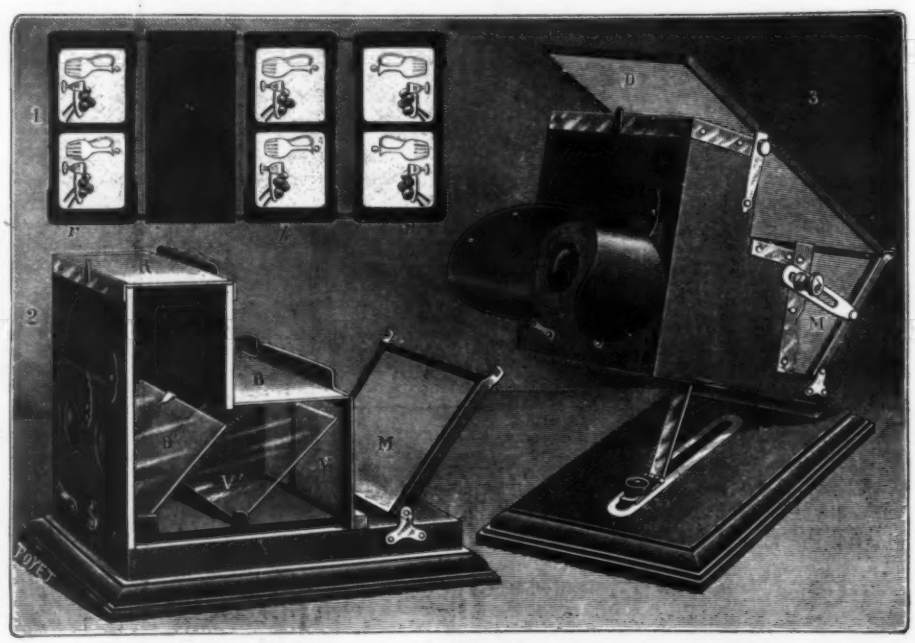
IN a communication on the casting of bronze statues, recently addressed to the Civil Engineers' Society of France, M. E. Maglin sketched the art of working in bronze from the earliest ages, while dwelling more particularly on the method of moulding known as the waste-wax process, says The Mechanical Engineer. In recent times several inventors had endeavored to make moulds of gelatine, the results of which were not encouraging; but it was given to a French sculptor—M. Le Bourg—to devise a method perfect as regards the results obtained, and also the saving in labor. This process depends upon the fact that gelatine, with the addition of glycerine and glucose, preserves a constant elasticity even when exposed to the atmosphere; and by its means a statue may be moulded in its entirety, being surrounded by an envelope, or covering, in two parts, which are detached with great facility, while producing moulds of remarkable sharpness. In this manner a wax is obtained by a single pouring, the seam of the mould joint being easily removed, since it is upon soft wax that the retouching has to be effected. This done—by the ordinary methods of the waste-wax process—the statue to be reproduced is covered with slip; the wax is melted out; and the bronze is run into the mould after the jets and vents have been arranged. The specially original point about this method is that, while affording a considerable number of copies, absolutely identical, it is independent alike of the sculptor, the chaser, and the bronze mounter.

THE IVES CHROMOSCOPE.

THE different processes of color photography have for some time past formed the subject of so large a number of descriptions that we shall not at present revert to them. We shall merely recall the one that has been most employed up to the present, and the principle of which, due to M. Ducos du Hauron, consists in making use of three fundamental colors for obtaining all the others. If, after making three negatives by placing before the objective three transparent screens, each of a different color, we print therefrom three positives and color each of them with a uniform tint, properly selected, we shall, upon superposing the positives, see the object reproduced with all the colors of the model, and even in relief if stereoscopy be employed.

As a general thing, the colors chosen for making the negative are blue, yellow, and red, and for the corresponding positives, ultramarine, green and orange. But we shall not dwell upon this, as it would be carrying us too far, and we have another object in view.

We merely desire to make known an apparatus based upon this principle, that is now to be found in the market and that is constructed by Messrs. Clement and Gilmer, according to instructions by Mr. Ives.



THE IVES CHROMOSCOPE.

The problem to be solved is as follows: Starting with three uncolored negatives obtained under the conditions mentioned above, to obtain the image of an object with all its colors and in relief. Mr. Ives obtains this result as follows: His apparatus, which is stereoscopic, consists of a box of which one of the ends is provided with two oculars. At the other extremity, one of the positives is placed vertically, at *V*, against a green glass. The two other positives are placed horizontally at the upper part of the box, one at *B*, upon a blue glass, and the other at *R*, upon a red one. Between the oculars and the positive, *V*, which is placed directly opposite, are interposed two glasses inclined at an angle of 45°. One of these, *B'*, is transparent blue and the other, *V'*, transparent green.

The eye sees the first image directly through *B'*, *V'*, and *V*, and through *B'* the second image coming from *B*, which is reflected at *V'*; and finally, the third image coming from *R*, which is reflected at *B'*. Through a perfect regulation of the apparatus, all these images become exactly superposed, aside from the ordinary superposition of stereoscopy. The positives are mounted on hinges (No. 1), and it suffices to introduce *v* into a groove arranged to that effect, and to allow *b* and *r* to remain in their respective places. Light is sent into the apparatus by a mirror, *M*, which, as well as the box (No. 3), has a variable inclination, so as to permit of obtaining a very uniform illumination. A ground glass, *D*, is placed over the whole, whenever necessary, in order to soften the light. The model that we have examined has given wonderful results. The colors of the screens have been selected with care, and are perfectly complementary, since the whites of the image are of absolute purity. For the above particulars and the illustration we are indebted to La Nature.

Boston's ten public ice water fountains cost the city forty cents apiece per day during the summer. Water Commissioner Murphy is now making arrangements whereby ice will be cut this winter from reservoirs belonging to the department, and the cost of the free ice water will be made merely nominal next summer.

WASTE HEAT AT SEA.*

ANY boiler is worked to the best advantage when the coldest portion of it is exposed to the coldest portion of the waste products of combustion. Rankine was, perhaps, the first to present this proposition; but Lord Dundonald was probably the first to put it in practice, and by special arrangements he is said to have succeeded in evaporating 13 pounds of water per pound of coal burned in the boiler of H. M. S. "Janus." In a recent impression we stated that the five-cylinder engines of the "Inchmona" use but 1·15 pounds of coal per horse per hour. If the boilers convert 10 pounds of water into steam per pound of coal, this means that the engines get along with only 11·5 pounds of steam per horse per hour. If the boilers of the "Inchmona" were as economical as that of the "Janus," then the consumption of fuel would be less than 0·9 pound per horse per hour. In all steamships a great deal of heat goes away up the chimney, in comparatively few ships is any attempt made to utilize it. When shipowners are advised to "do something," they very commonly reply either that the saving to be effected is not worth the cost incurred in getting it, or that, in point of fact, any apparatus would interfere with the draught, or would be dangerous, and, finally, that if a boiler is properly proportioned and properly worked, no more heat goes up the chimney than is necessary. A somewhat extended experience with marine boilers leads us to state that the great majority of them are not so designed or worked that no heat is wasted. Red hot uptakes are not so rare as they ought to be; and we see the paint burned off even the outside casings of chimneys now and then. The tubes are too large in diameter and too short in the ordinary Scotch boiler to permit all the heat to be taken up. Even the moderate use of fans in the base of a funnel is attended with the difficulty that the blades are apt to become overheated and warped, and it has been found advisable before now to make the fan shaft hollow, and pass a stream of water through it. It is, however, waste of time to insist on a condition which is patent to every engineer with any sea experience.

There are three well known schemes for utilizing waste heat, and we are about to suggest a fourth. The first is to heat the feed water; the second is to superheat the steam; the third to raise the temperature of the air wanted for combustion. Examples of the latter plan are supplied by the Howden and the Eaves and Ellis systems. Superheating promises fine results, which have been partially realized in practice; but there are difficulties. The principal one is the rapid destruction of the superheater. As this need not be an expensive appurtenance, the cost entailed by its destruction is a secondary matter. The danger, however, incurred by the failure of a tube in these days of high-pressure steam is not inconsiderable. As a matter of fact, however, no one has as yet thought of patenting and putting on the market a superheater which will be as self-contained and marketable an article as an evaporator or a feed pump. It must be so contrived that it can be placed, say, in the root of the chimney, and coupled up to the boiler on the one hand and the main steam pipe on the other. It is not by any means essential that all the steam should pass through it. Wetherhed, it will be remembered, was very successful, and he only mixed about 10 per cent. of very hot steam with the main supply. In order to avoid risk, a self-closing valve of the kind now pretty well known may be fitted, to prevent any dangerous rush of steam, should a tube burst. In this way, we think, superheating has a far greater chance of success than in any other. Shipowners are naturally somewhat reluctant to make a superheater an integral part of a large marine boiler.

Various schemes have been proposed and tried for heating feed water at the root of the funnel, or in the uptake. Some of these have been successful. The most radical departure from existing practice in this direction is being made by Mr. Thompson, of Dundee, who has fitted a Green's economizer, with its tubes and scrapers, over the boilers. This, of course, involves weight, complication, and cost; but the saving effected is probably a sufficient return. So considerable an authority as Mr. Mudd holds that if space on board ship were of small account, it is not improbable that

* From The Engineer.

all the three methods we have named could be utilized at once. The waste gases, being hotter than the boiler steam, could be first used to superheat it; then they might be employed to heat the feed water, and they would still after that be hot enough to raise the temperature of the air on its way to the furnace. Of course, in this case fans would be necessary to assist the draught. In small ships this plan could not be carried out, but in such huge craft as the "Oceanic" almost anything is possible.

We have said that we are about to propose a fourth scheme; it was, we may add, suggested several years ago in our pages, but only for land engines. It is, however, quite applicable to marine engines. It is to circulate hot water instead of steam in the jackets of the cylinders. The practical details do not present any difficulty of design. Coils of suitable copper piping could be fitted in the chimney root, and led thence to the cylinder jackets. The temperature of the water might be obtained not many degrees below that of the waste gas, if desired, and circulation would probably be kept up automatically; if not, a very simple pumping arrangement could do what was wanted. The direct advantage would be that all that jacketing can now effect, and probably something more, could be had, while the loss represented in the condensation in the jackets, amounting to 2½ pounds to 3 pounds per horse power per hour in really efficient jackets, could be saved, as all the heat would be got out of the waste gases. If the surface available for heating the water was not sufficient to keep up the temperature in all the jackets, then only one or two cylinders might be water-jacketed, leaving but two or one to be jacketed with steam.

If any of our readers who have practical acquaintance with the Scotch boiler will take the trouble to work this suggestion out even roughly, he will see how little difficulty there is in carrying it into practice. The whole apparatus would be extremely simple, and as it would have no direct communication with the main boiler, the bursting of a pipe, which would probably occur, if at all, in the uptake, would do very little harm, and would not risk life. It is likely that the water would, for well known reasons, prove a better heating agent than steam. If it was feared that danger might result from the use of water under a high pressure at a high temperature, it would be easy to substitute an oil with a high ebullition point, and then there need be little or no pressure in the jackets.

"SODOR."*

SELDOM indeed has a product been offered to the public which owes its origin to such entirely new achievements of science as "sodor." The name itself is so new that most readers will glance up and ask: "Sodor? What is that?"

But this is the very purpose of him who invented the term; the name was to be striking and was to impress itself on the memory of the hearer. This wish in itself is as modern as the whole invention. But as the latter day advertisement depends for its effectiveness not only on striking terminology, but upon the existence of a real, intrinsic value in the much extolled article, so the strange name "sodor" connotes so much technical knowledge that it is worth while to become more intimately acquainted with this original product.

Sodor is nothing but a small, smooth, bottle-like capsule of iron weighing 8·7 grammes (0·3 oz.) and filled with liquefied carbon dioxide. Ten of these capsules are packed in a pasteboard box and are sold in Germany for a few cents. An open box containing sodors is shown in Fig. 1.

Sodor is the invention of a certain Herr Sterne and is manufactured in Zürich. To place upon the market small capsules filled with liquid carbon dioxide is assuredly a bold undertaking which could be attempted only with the assistance of the most perfect appliances of our times; no less remarkable is the price at which sodor is thus sold—a price which, in spite of its insignificance, must necessarily leave a profit.

That small, measured quantities of liquefied carbon dioxide are serviceable for many purposes, is self-evi-

FIG. 1.—A BOX OF SODORS.

dent. At the present time sodor is used for a single purpose, which use, to be sure, would in itself exhaust the entire output of a large factory were the product more widely known. Sodor is recommended as the simplest and most convenient source of pure carbon dioxide for the preparation of carbonated beverages. The apparatus, which for this purpose has been introduced by the makers of the product, is no less ingenious than sodor itself.

The function of the apparatus consists in opening the sealed sodor capsules with safety, in catching up without loss the carbon dioxide escaping under enormous pressure, and in conducting the gas into the liquid to be saturated therewith. All this is performed by the sodor-bottle shown in Figs. 2 and 3, which is not unlike a neatly formed beer-bottle incased in wickerwork and provided with a patent stopper or cap. Indeed, the peculiarity of this bottle resides in the internal construction of this cap.

The sodor, as indicated in Figs. 2 and 4, fits in the mouth of the open bottle and is inserted with the tapering portion pointing down. The capsule would

FIG. 2.—A SODOR-BOTTLE, WITH THE CAP RAISED TO SHOW THE SODOR IN POSITION.

close the bottle like a ball-valve, were it not for three narrow grooves cut in the edge of the cap. In the head of the cap a strong steel pin is screwed; a layer of rubber prevents a total loss of communication with the exterior during the depression of the head. As indicated in Fig. 3, the bottle is corked by means of a powerful lever, the previously mentioned pin being thereby forced into the bottom of the sodor, purposely made thinner than the side walls. The pin's being formed with a lateral slip causes the carbon dioxide to escape from the sodor and to force its way through the three previously mentioned fine grooves in the neck of the bottle and thus into the bottle itself. The liquid contained in the bottle rapidly dissolves the gas. The thick walls of the bottle are not readily broken by the pressure of the gas; but, should they burst asunder, the scattering of the broken pieces of glass would be prevented by the wickerwork. In order that the saturation of the liquid may progress at an approximately uniform pressure, a red strip is secured to the wickerwork for the purpose of indicating the height to which the bottle may be filled.

From the foregoing it follows that with a sodor capsule it is at all times possible to produce a bottle of sodawater. A sodor capsule contains 2·3 grammes (0·64 fluid dram) of liquid carbon dioxide. Since but little gas is lost, it may be safely said that at least two grammes (0·56 fluid dram) are forced into the liquid.

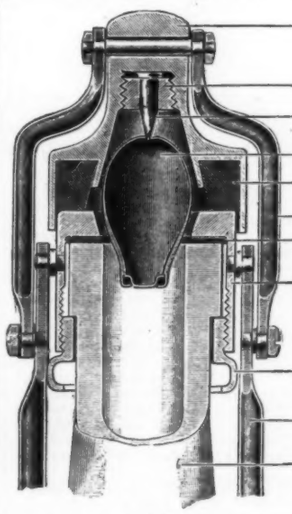


FIG. 4.—SECTION OF A BOTTLE SHOWING THE PIERCING PIN IN OPERATION.

The low price at which bottled sodawater is sold in large cities would hardly permit sodor to compete with large sodawater manufactories. Sodor, however, serves a far different purpose. Of all men, tourists would carry the new apparatus with them on their journeys. For, though the sodawater sold in large cities is of great purity, that made in places far removed from manufacturing towns is of a questionable quality. In such places clean water can be transformed into a sparkling drink, in which all deadly germs have been destroyed by the carbon dioxide. Sodor can be used not only in converting ordinary water into sodawater, but it can also be employed in carbonating milk, tea, undiluted wine, fruit juices, and other liquids.

The method of manufacturing these sodors is as interesting as the use of the product. The liquefaction of gases is an achievement of which we moderns may well be proud. But, if it is a splendid feat to force liquefied gases into steel bottles of two or three gallons capacity, it is, of a surety, more wonderful if a manufacturer can successfully undertake to sell in small capsules so refractory a gas, gifted as it were with a will and a power of its own.

Carbon dioxide, as everyone knows, has a critical temperature of 31° C. and a critical pressure of 77 at-

FIG. 3.—POSITION OF THE CAP AND OF THE HANDS BEFORE PIERCING THE SODOR.

mospheres. The iron sodor-capsules, it is claimed, are capable of withstanding a pressure of 500 atmospheres; whereas the pressure exerted by the carbon dioxide under ordinary conditions will hardly exceed eighty atmospheres.

The capsules are made by special machines quite similar to those used in the manufacture of metallic cartridges. From a sheet of iron, small, round disks are stamped, which are gradually drawn into a pear-shaped form. The material, in order to be easily worked, must be repeatedly annealed, for which purpose it is packed in boxes and heated. When the capsules have received their final form, they are filled with liquid gas and sealed by a machine, the peculiar construction of which has been kept secret. The stopper by which the capsule is closed comprises a cover overlapped by the crimped edge of the sodor. The greater the internal pressure, the more tightly will the cover be forced into contact with the inwardly bent edge of the capsule. The construction of this cover is plainly to be seen in Fig. 4. Placed in position, the cover can never be removed, the sodor, as we have already seen, being opened by the piercing of the bottom. Once opened, the capsule can no longer be used.

Of the other possible uses of sodor, one has already been suggested, in the unmistakable similarity which a capsule bears to a cartridge. Both are formed from metal disks by similar machines; both are made to withstand great internal pressure; both are pierced by pins. It is not utterly impossible that sodors may be used in connection with air-guns, and that in condensed gases may be found the ideal smokeless powder of the future. It would be necessary only to fill a capsule with liquid air instead of liquid carbon dioxide.

The manufacturers of sodor have not concerned themselves with such speculations. They doubtless know, as well as all investigators of the properties of condensed gases, that liquid carbon dioxide and liquid air are two entirely different things, and that the effect of a suddenly liberated, condensed gas is by no means the same as that of a gas produced under pressure by the explosion of a solid body. Fully conscious of the vast difficulties which the experimental investigation of this subject involves, the makers of sodor, if they have begun such investigations, will not publish their discoveries until they can point to results as technically developed as sodor itself.

THE FIRST ELEVATOR.

ELEVATORS, or lifts, as they are called in England, are now considered indispensable in high buildings, but on the European continent they are seldom found, even in the better hotels. This is the more surprising since the invention originated in Central Europe. The earliest mention of the elevator is made in a letter of Napoleon I., addressed to his wife, the Archduchess Maria Louise. He writes to her that, when in Schoenbrun, then the summer residence of the Austrian Emperor, near Vienna, he used the "chaise volante" (flying chair) in that castle, which had been constructed for Empress Maria Theresa, to save her the annoyance of climbing up the long flight of stairs. It consisted of a small square room, sumptuously furnished with hangings of red silk, and suspended by strong ropes, with counterweights, so that it could be pulled up or let down with great ease in a shaft built for the purpose about 1760. The great Corsican mentions that when he first entered the "flying chair" he was asked for his weight and that of his two companions, probably in order to employ the proper counterweights, since it was difficult for the operators to stop at the right point unless weights were about even.

A similar elevator was built in the castle of Duke Charles of Lorraine about the same time, but this one was simpler, consisting only of a chair on a platform.—Philadelphia Record.

* Translated from Prometheus.

THE MICRONESIAN VENICE.

AT a recent meeting of the Royal Geographical Society, says The Architect, a paper was read by F. W. Christian, in which he described his visit to the Eastern Caroline Islands and his explorations among the famous ruins of Nan-Matal. He said that the area occupied by the islets of Nan-Matal is about nine square miles. For the most part they are deserted, and altogether there are not above twenty people living on the three or four inhabited ones. Some of them are planted with cocoanuts and bread fruit, and are visited occasionally by fishing parties. The king's island of Tomun and the shores of Metalanim harbor are fairly thickly populated, but the folk as a rule give Nan-Matal a pretty wide berth. They say the place is haunted, and on certain of the islets, such as Pan-Katara and Pei-Kap, nothing will induce them to set foot. All the enormous quantity of basalt which the ancient builders used must have been brought in canoes or rafted down the coast, a distance of twenty to thirty miles. These pillars and blocks were carried down to the sea from the dales below the precipices of U and the great perpendicular scarp of Chokach, where the columnar basalt formation is very strikingly marked. Here were grand natural quarries, whence the builders might select all the shafts and pillars required, lying around ready shaped to their hands.

The first of the islets visited from Uchentau was Nan-Tauach, the most remarkable of all the Metalanim ruins. The water front is faced with a solid terrace of massive stonework about 6 feet wide, standing over 6 feet above the shallow waterway. Above is a striking example of immensely solid cyclopean masonry. A great wall, between 20 feet and 30 feet high and about 10 feet in thickness, formed of basaltic prisms laid alternately lengthwise and crosswise, incloses an oblong space, which can be entered only by the great gateway in the middle of the west face and by a small portal in the northwest corner. The right side of the gateway is overshadowed and all but hidden from view by the dense leafage of a huge Ikoik tree. In olden times the walls must have been considerably greater in height, but much of the masonry has now fallen into lamentable ruin. A series of huge rude steps leads into a spacious courtyard, strewn with fragments of fallen pillars. This encircles a second terraced inclosure topped by a remarkable projecting frieze or cornice of stonework. The outer inclosures were 185 feet by 115 feet, the wall varying in height from 20 feet to nearly 40 feet, the inner, which forms a second conforming parallelogram, measuring 85 feet by 75 feet. Height of the wall, 15 feet to 18 feet; average thickness, 8 feet.

Another rude flight of steps leads up to the great central vault or treasure chamber, said to be the grave of an ancient monarch, who bore the dynastic title of Chau-te-Leur. It was difficult to gain much information about the old traditions at first. The natives certainly know something about the history of these ruins, but do not care to talk of them to strangers. This reticence he had patiently to overcome little by little, and consequently bit by bit a tolerably explicit little chapter of history was built up. It appeared that in olden days Ponape was much more populous than at present. All the tribes in the days of the builders were united under a powerful line of kings. The last of this dynasty met his death facing a great invasion of barbarians from Pati-Air, the barren lands of the south, probably some portion of New Guinea, the New Hebrides, or some neighboring portion of Melanesian area. They arrived in a great fleet of canoes under the command of a fierce and terrible warrior, Icho-Kalakal. The savage invaders poured in upon the peaceful settlers and blotted out the ancient civilization, after a great battle, in which numbers were slain on both sides. Part of the walls were thrown down and the defenders were either slain in battle or offered up in solemn sacrifice to the war gods of their conquerors.

King Chau-te-Leur himself, in his flight, perished in the waters of the Chapalap River, at the head of Metalanim harbor. The Ani changed him into a blue river fish, which the folk of Metalanim to this day will not eat. The underground chamber or vault which bears King Chau-te-Leur's name lies right in the center of the inner precinct, facing the great gateway. It is about 8 feet in depth, roofed in with six enormous slabs of basalt. The flooring was paved by some heavy basalt blocks, which they had great trouble in lifting away. Below this was a layer of soft vegetable mould, thickly matted with a tough root growth that made excavation somewhat troublesome. The side nearest the entrance threatened soon to fall into ruins, and they had to pursue digging operations very cautiously in this corner for fear of being crushed by the collapsing of these mighty masses of masonry.

There are three other tombs or vaults besides the large central one, situated on the southwest, east, and northwest sides respectively. They are smaller in size, and gave up rather scanty results to their excavators. The one on the east side is very narrow and some 12 feet in depth. Paul, the king of the Metalanim tribe, sometimes used them as dungeons to confine those who offended him—a punishment greatly dreaded by the natives, in their childlike horror of the dark and of the viewless spirit forms with which their fancy peoples these lonesome places. "The eyes of the spirits are watching everything you do," said Keroun, one of the lecturer's workmen, as he tendered his resignation. "I know they are angry; they will not injure you because you are a white man, but they will punish us. I am very much afraid; I cannot sleep at night, and I would like to go home."

Standing in the southwest angle, where the wall is nearly 40 feet in height, one looked down upon a green abyss of nodding woodland, with never a glimpse of the network of canals rippling below. The northeast angle is occupied by an enormous banyan tree, towering full 50 feet above the masonry in which it stands firm rooted, thrusting its bunches of thread-like root fiber into every crevice. These, as they swell, exercise a constant and gradually increasing force, wrenching the blocks out of place. When a high wind blows the structure is racked through and through in every joint and keystone. Sooner or later, if nothing is done to remove the tree, this side of the wall will settle down into ruins. A tangle of weeds, grasses, and creepers thickly carpets the precinct. Beyond the two small cross walls on the inner side of the great outer wall on the southwest side is a remarkable slab, inclining to a crescent shape, balanced on two solid shafts projecting out of the masonry. This, when tapped, gives a clear, ringing sound, and was probably used for an alarm or for a sort of a bell in sacred ceremonies.

The northwest angle gives a happy impression of the style of architecture, the two walls at their junction running up high and bluff like the bows of a Japanese junk. Beneath, the terrace fronting the waterway is overgrown by a belt of young cocoa palms of recent growth. News of the excavations, and of the havoc being made in the jungle in clearing operations, finally reached the ears of King Paul, who at once put a stop to the work. Most unfortunately, his superstitious terrors were confirmed by a very severe epidemic of influenza that broke out in the tribe shortly after their departure, and carried off many of the Metalanim people. The result of the excavations in the central vault was distinctly encouraging, and it was a great pity more time could not have been spent at it. Thoroughly to explore and clear the labyrinth of this Micronesian Venice and to make complete excavations would take several months' hard work. It was very difficult to get the natives to work here, owing to their dread of the vengeance of the ancestral spirits and heroes hovering around these holy places, ready to let loose some terrible judgment upon the head of rash intruders. Another great drawback to exploration likely to continue during the reign of King Paul is a deep-seated hostility to the white man felt by many of the Metalanim tribesmen.

BIGNONIA PURPUREA.

THE subject of the accompanying illustration is one of the most effective and beautiful of stove climbers.

BIGNONIA PURPUREA—FLOWER LOBES ROSY PURPLE, THROAT WHITE.

It forms a large specimen in the Palm House of the Botanic Garden at Cambridge, and growing as it does on a rafter, numerous pendent branches formed quite a curtain of flowers. The color is bright rosy purple, with paler throat, but not so conspicuously white as might be inferred from the drawing.

The specimen is planted out, and grows vigorously. The stems are round; the leaves sometimes trifoliolate, though mostly bifoliolate, with petioles about 1 inch long, the secondary measuring about half as much; the leaflets are broadly ovate and shortly acuminate, from 3 to 3½ inches long, rarely with the teeth shown in the illustration. The cluster of flowers is well represented, and, as may be observed, there are flower stalks above and below, the flowers belonging to which could not be shown. Culture is quite of the easiest, but it is worth remark that planting out has no doubt produced a superior result. The plant is a native of tropical South America.

We are indebted to The Gardeners' Chronicle for the engraving and particulars.

PEANUTS AND PEANUT OIL.

THE earth nut, ground nut, goober, pindar, or peanut (Arachis hypogæa), as it is variously called, is a low, somewhat creeping annual belonging to the bean family. It is a native of the tropics, but has been for a long time cultivated very extensively in Africa, India, the West Indies, and warmer portions of America. Only the lowest flowers bear fruit, and after blooming these flowers lengthen their stems, which penetrate the ground several inches, where the fruit ripens. The fruit is 2 or 3 cm. long and 1 to 1·5 cm. thick, with a furrowed, yellowish pod, which contains from one to four seeds, one or two being the common number. In addition to their general use for food and confectionery, the seeds furnish 38 to 50 per cent. of oil. The first cold pressing yields an almost colorless oil of pleasant taste and smell, which is said to be excellent for table use.

After the first pressing the seeds are sprinkled with water and pressed again, cold, to obtain the oil, which is also used to some extent for food purposes, but mostly for illumination. The third oil is extracted by warm pressure, and is in great demand for making various kinds of soaps. The cake or residue is considered an excellent food for stock. The peanuts grown in tropical countries are said to yield a much greater per cent. of oil than those raised in temperate regions. In the United States peanuts are usually planted after corn, two bushels of seed being used to the acre. Planting takes place as soon as all danger from frost is past. It is said that a warm, sandy loam containing some lime is the best soil for peanuts. The crop is variously stated to be from 80 to 120 bushels an acre. The oil is chiefly extracted at Marseilles, France, which annually imports millions of pounds of peanuts. In this country peanuts are used principally for eating. In other countries they are not esteemed so highly as food; hence nearly all the foreign product is used for oil.

According to the latest Year Book (1897) issued by the Department of Agriculture, the imports of "peanuts and other ground nuts," which at one time constituted an important item, valued at $194,387 in 1864, have fallen to $2,106.85 in 1897, while the imports of the shelled nuts have fallen from 1,104,018 pounds valued at $34,401 in 1872, to 1,060 pounds valued at $9.14 in 1897. These decreases are due to the increased domestic production. From the same authority we learn that under the name of "peanut meal" a material has been sold consisting of ground peanut hulls or shells, and even less valuable as a food than cottonseed hulls. As peanut meal, which consists of the kernel of the peanut from which the fat has been partially extracted, is one of the richest eating stuffs for stock, containing over 47 per cent. of protein, the use of the name was clearly fraudulent. "Peanut feed," which appeared to be the peanut shells finely ground, with a small mixture of inferior nuts, was found at the Massachusetts Agricultural Experiment Station to be only 32 per cent. digestible, and to contain over 50 per cent. of woody fiber.

Considerable information regarding peanut oil and its use in pharmacy and the arts may be found in a paper by Prof. S. P. Sadtler, of Philadelphia, in this journal, September 23, 1897, page 416. Chemically, peanut oil is distinguished from the other oils of the olive group in containing the glycerides of two of the higher fatty acids of the saturated series, namely, arachidic acid and lignoceric acid, along with the oleic acid of the unsaturated series.—Pharmaceutical Era.

BEHAVIOR OF AIR UNDER GREAT ELECTRICAL STRESS.

IN a recent issue of The Philosophical Magazine, J. Trowbridge states that in his latest transforming apparatus, consisting of 120 condensers, he has obtained the unprecedented electric motive force of 3,000,000 volts. The behavior of air under this electrical stress is interesting. Its initial resistance is greatly reduced, and the curve expressing the relation between spark length and electromotive force departs from a straight line beyond 1,200,000 volts and approaches the voltage axis. Thus the extreme length of the spark in air obtained with 3,000,000 volts is 6½ feet; whereas a length of at least 10 feet should have been attained if the proportionality between spark length and voltage had been maintained. This departure from proportionality is due to the increased conducting power of

the air, for a powerful brush discharge is seen to proceed from the terminals of the apparatus to the floor and the walls of the room. In spite of special precautions, a portion of the discharge was always shunted, so to speak, through the surrounding air. The spark preferred to leap through 3 inches or 4 inches of air to passing through 1,000 ohms of sulphate of copper between terminals of copper 1 square centimeter in area. It is probable that with still higher voltage the initial resistance of the air would still further diminish, and would be of the order of metals. The initial resistance, too, of highly rarefied media diminishes in a similar manner. Thus, a Crookes tube which resists the passage of an 8 inch spark is brilliantly lighted by a difference of potential of 3,000,000 volts, and one discharge of a millionth of a second is sufficient to obtain a photograph of the bones of the hand.

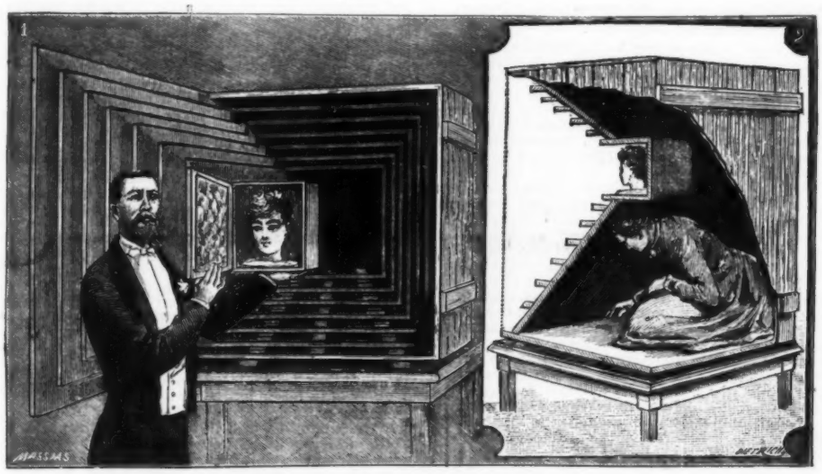
THE "SECRET OF THE HAREM."

M. ALBER, the prestidigitator, describes in La Nature a new trick which was arranged by him last winter, and which has never before been explained in print.

A large packing-case is brought in and placed upon a small table. The prestidigitator then tells an extraordinary story about a decapitation that took place in Turkey by order of some vizier or other, about the head being picked up and placed in a box, and about the presence of the latter, with the head well preserved and alive, in the packing-case that has just been introduced.

In order to confirm his statement, he proceeds to open the case, which he pretends has been turned wrong end foremost by the porters. The latter are then called back and ordered to turn the case around. This gives the spectators an opportunity to see every side of it and verify its perfect continuity. The case is then opened and is found to contain a second one, and then a third one, etc., which, upon being opened successively, shaken, and slid one into another in order to prove their mobility, allow to be seen a painted box ornamented with iron work, which the operator extracts from the cases and carries toward the spectators.

This box contains a woman's head, with a red and gold Oriental head-dress, placed upon a green plush



THE SECRET OF THE HAREM.

cushion. After the spectators have taken a good look at this head, the box is closed and put back in the cases. Those of the latter that had been more or less drawn out from one another at the moment of opening are now shoved in. The central box is then immediately reopened, in order that the spectators may see that the female head is really alive, which it proves by opening the eyes, singing, answering questions, guessing cards, etc.

The following is an explanation of the trick: The large external case and the box in the center are complete, while the cases that slide one into the other have no back. The latter, in fact, are merely square tubes provided with a cover on the side toward the spectators. In order that the person whose head is to appear in the box at a given moment may conceal herself, all the false boxes are beveled off at the back and upon the sides, as shown in the section to the right of the figure. Besides, in order to obtain the height necessary to accommodate the confederate, the boxes are separated from each other by wedges of hay. It is impossible for the spectators to see how it can be possible for a person to be concealed in cases that they naturally suppose to be complete; and what adds further to the illusion is that (as has been said) the cases are slid out and in from time to time.

After we have stated that at the beginning of the exhibition of the trick there is in the central box a wax head, moulded upon the head of the living person and resembling that of the latter exactly as to head-gear, one will have a complete explanation of the illusion. When the box is taken out, the spectators see the last case open, complete, and surrounded by all the others. When the closed box is returned to the case, the concealed person turns the pivoted bottom of the latter around, and is thus able to reach the box. Upon a spring being pressed, the bottom of the box swings like a trap and allows the wax head and the back half of the plush cushion to slide. The concealed person grasps the head and places it in a bag fixed alongside of her, and then inserts her own head, which already has, in lieu of a collar, the back part of the cushion. She then closes the trap, and when the box is opened anew nothing seems changed, and the head appears to be the same one that was previously seen.

The confederate is quite comfortably situated in the open space formed by the beveling of the cases, and it is only at the beginning of the trick, while the box is removed, that she is obliged to sit in an awkward position with her back bent so as to bring her head beneath the last case.

What does much for the success of this trick is that the spectators always look for an explanation of it in the use of mirrors, while, as a matter of fact, no mirrors are employed.

[Continued from SUPPLEMENT, No. 1201, page 19261.]

A SHORT HISTORY OF SCIENTIFIC INSTRUCTION.*

II.

I MUST come back from this excursion to call your attention to the year 1845, in which one of the germs of our college first saw the light.

What was the condition of England in 1845? Her universities had degenerated into hauts lycées. With regard to the university teaching, I may state that even as late as the late fifties a senior wrangler—I had the story from himself—came to London from Cambridge expressly to walk about the streets to study crystals, prisms, and the like in the opticians' windows. Of laboratories in the universities there were none; of science teaching in the schools there was none; there was no organization for training science teachers.

If an artisan wished to improve his knowledge, he had only the moribund mechanics' institutes to fall back upon.

The nation which then was renowned for its utilization of waste material products allowed its mental products to remain undeveloped.

There was no minister of instruction, no councilors with a knowledge of the national scientific needs, no organized secondary or primary instruction. We lacked then everything that Germany had equipped herself with in the matter of scientific industries.

Did this matter? Was it more than a mere abstract question of a want of perfection?

It mattered very much! From all quarters came the cry that the national industries were being undermined in consequence of the more complete application of scientific methods to those of other countries.

The chemical industries were the first to feel this, and because England was then the seat of most of the large chemical works.†

Very few chemists were employed in these chemical works. 'There were in cases some so-called chemists at about bricklayers' wages—not much of an inducement to study chemistry; even if there had been practical laboratories, where it could have been properly learnt. Hence, when efficient men were wanted they were got from abroad, i. e., from Germany, or the richer English had to go abroad themselves.

At this time we had, fortunately for us, in England, in very high place, a German fully educated by all that could be learned at one of the best equipped modern German universities, where he studied both science and the fine arts. I refer to the Prince Consort. From that year to his death he was the fountain of our English educational renaissance, drawing to himself men like Playfair, Clark, and De la Beche: knowing what we lacked, he threw himself into the breach. This college is one of the many things the nation owes to him. His service to his adopted country, and the value of the institutions he helped to inaugurate, are by no means even yet fully recognized, because those from whom national recognition full and ample should have come were, and to a great extent still are, the products of the old system of middle age scholasticism which his clear vision recognized was incapable by itself of coping with the conditions of modern civilized communities.

It was in the year 1845 that the influence of the Prince Consort began to be felt. Those who know most of the conditions of science and art then and now know best how beneficial that influence was in both directions; my present purpose, however, has only reference to science.

The College of Chemistry was founded in 1845, first as a private institution; the School of Mines was established by the government in 1851.

In the next year, in the speech from the throne at the opening of Parliament, Her Majesty spoke as follows: "The advancement of the fine arts and of practical science will be readily recognized by you as worthy the attention of a great and enlightened nation. I have directed that a comprehensive scheme shall be laid before you having in view the promotion of these objects, toward which I invite your aid and co-operation."

Strange words these from the lips of an English sovereign!

The government of this country was made at last to recognize the great factors of a peaceful nation's prosperity, and to reverse a policy which has been as disastrous to us as if they had insisted upon our naval needs being supplied by local effort as they were in Queen Elizabeth's time.

England has practically lost a century; one need not be a prophet to foresee that in another century's time our education and our scientific establishments will be as strongly organized by the British government as the navy itself.

As a part of the comprehensive scheme referred to by Her Majesty, the Department of Science and Art was organized in 1853, and in the amalgamation of the College of Chemistry and the School of Mines we have the germ of our present institution.

But this was not the only science school founded by the government. The Royal School of Naval Architecture and Marine Engineering was established by the department at the request of the Lords Commissioners of the Admiralty "with a view of providing especially for the education of shipbuilding officers for Her Majesty's service, and promoting the general study of the science of shipbuilding and naval engineering." It was not limited to persons in the Queen's service, and it was opened on November 1, 1864. The present Royal College of Science was built for it and the College of Chemistry. In 1873 the school was transferred to the Royal Naval College, Greenwich, and this accident enabled the teaching from Jermyn Street to be transferred and proper practical instruction to be given at South Kensington. The Lords of the Admiralty expressed their entire satisfaction with the manner in which the instruction had been carried on at South Kensington; and well they might, for in a memorandum submitted to the Lord President in 1887, the president and council of the Institute of Naval Architects state: "When the department dealt with the highest class of education in naval architecture by assisting in founding and by carrying on the School of Naval Architecture at South Kensington, the success which attended their efforts was phenomenal, the great majority of the rising men in the profession having been educated at that institution."

Here I again point out, both with regard to the School of Mines, the School of Naval Architecture, and the later Normal School, that it was stern need that was in question, as in Egypt in old times.

Of the early history of the college I need say nothing after the addresses of my colleagues, Professors Judd and Roberts-Austen, but I am anxious to refer to some parts of its present organization and their effect on our national educational growth in some directions.

It was after 1870 that our institution gradually began to take its place as a normal school, that is, that the teaching of teachers formed an important part of its organization, because in that year the newly established departments having found that the great national want then was teachers of science, began to take steps to secure them. Examinations had been inaugurated in 1859, but they were for outsiders, conferring certificates and a money reward on the most competent teachers tested in this way. These examinations were really controlled by our school, for Tyndall, Hofmann, Ramsay, Huxley, and Warington Smyth, the first professors, were also the first examiners.

Very interesting is it to look back at that first year's work, the first cast of the new educational net. After what I have said about the condition of chemistry and the establishment of the College of Chemistry in 1845, you will not be surprised to hear that Dr. Hofmann was the most favored—he had forty-four students.

Prof. Huxley found one student to tackle his questions, and he failed.

Professors Ramsay and Warington Smyth had three each, but the two threes only made five; for both lists were headed by the name of

Judd, John W.,
Wesleyan Training College,
Westminster.

Our present dean was caught in the first haul.

These examinations were continued till 1866, and upward of 600 teachers obtained certificates, some of them in several subjects.

Having secured the teachers, the next thing the department did was to utilize them. This was done in 1859 by the establishment of the science classes throughout the country, which are, I think, the only part of our educational system which even the Germans envy us. The teaching might go on in schools, attics, or cellars, there was neither age limit nor distinction of sex or creed.

Let me insist upon the fact that from the outset practical work was encouraged by payments for apparatus, and that latterly the examinations themselves, in some of the subjects, have been practical.

The number of students under instruction in science classes under the department in the first year in which these classes were held was 442; the number in 1897 was 202,496. The number of candidates examined in the first year in which local examinations were held was 650, who worked 1,000 papers; in 1897 the number was 106,185, who worked 159,724 papers, chemistry alone sending in 28,891 papers, mathematics 24,764, and physiography 16,879.

The total number of individual students under instruction in science classes under the department from 1859 to 1897 inclusive has been, approximately, 2,000,000. Of these about 900,000 came forward for examination, the total number of papers worked by them being 3,195,170.

Now, why have I brought these statistics before you?

Because from 1861 onward the chief rewards of the successful students have been scholarships and exhibitions held in this college; a system adopted in the hope that in this way the numbers of perfectly trained science teachers might be increased, so that the science classes throughout the country might go on from strength to strength.

The Royal Exhibitions date from 1863, the national

* An address delivered at the Royal College of Science by Sir Norman Lockyer, K.C.B., F.R.S., on October 6.

† Perkin, Nature, xxxii., 304.

scholars from 1884. The free studentships were added later.

The strict connection between the science classes throughout the country and our college will be gathered from the following statement, which refers to the present time:

Twenty-one Royal Exhibitions—seven open each year—four to the Royal College of Science, London, and three to the Royal College of Science, Dublin.

Sixty-six National Scholarships—twenty-two open each year—tenable, at the option of the holder, at either the Royal College of Science, London, or the Royal College of Science, Dublin.

Eighteen Free Studentships—six open each year—to the Royal College of Science, London.

A royal exhibition entitles the holder to free admission to lectures and laboratories and to instruction during the course for the associateship—about three years—in the Royal College of Science, London, or the Royal College of Science, Dublin, with maintenance and traveling allowances.

A national scholarship entitles the holder to free admission to lectures and laboratories and to instruction during the course of the associateship—about three years—at either the Royal College of Science, London, or the Royal College of Science, Dublin, at the option of the holder, with maintenance and traveling allowances.

A free studentship entitles the holder to free admission to the lectures and laboratories and to instruction during the course for the associateship—about three years—in the Royal College of Science, London, but not to any maintenance or traveling allowance.

Besides the above students who have been successful in the examinations of the science classes, a limited number (usually about 60) of teachers, and of students in science classes who intend to become science teachers, are admitted free for a term or session to the courses of instruction. They may be called upon to pass an entrance examination. Of these, there are two categories—those who come to learn and those who remain to teach; some of the latter may be associates.

Besides all these, those holding Whitworth scholarships—the award of which is decided by the science examinations—can, and some do, spend the year covered by the exhibition at the college.

In this way, then, is the Ecole Normale side of our institution built up.

The number of government students in the college in 1872 was 25; in 1886 it was 113, and in 1897 it was 186.

The total number of students who passed through the college from 1882–1883 to 1896–1897 inclusive was 4,145. Of these, 1,966 were government students. The number who obtained the associateship of the Royal School of Mines from 1851 to 1881 was 198, of whom 39 were government students, and of the Royal College of Science and Royal School of Mines from 1882 to 1897 the number was 535, of whom 323 were government students. Of this total of 362 government students, 94 were science teachers in training.

With regard to the Whitworth scholarships, which, like the exhibitions, depend upon success at the yearly examinations throughout the country, I may state that six have held their scholarships at the college for at least a part of the scholarship period and three others were already associates.

So much for the prizemen we have with us. I next come to the teachers in training who come to us. The number of teachers in training who have passed through the college from 1872 to 1897 inclusive is about 600; on an average they attended about two years each. The number in the session 1872–73, when they were first admitted, was 16, the number in 1885–86 was 50, and in 1896–97, 60. These have not, as a rule, taught science classes previously, but before admission they give an undertaking that they intend to teach. In the earlier years some did not carry out this undertaking, doubtless because of the small demand for teachers of science at that time. But we have changed all that. With but very few exceptions, all the teachers so trained now at once begin teaching, and not necessarily in classes under the department. It is worthy of note, too, that many royal exhibitioners and national scholars, although under no obligation to do so, also take up science teaching. It is probable that of all the government students now who pass out of the college each year, not less than three-fourths become teachers. The total number of teachers of science engaged in classes under the department alone at the present time is about 6,000.

I have not yet exhausted what our college does for the national efforts in aiding the teaching of science.

When you, gentlemen, leave us about the end of June for your well-earned holidays, a new task falls upon your professors in the shape of summer courses to teachers of science classes brought up by the department from all parts of the four kingdoms to profit by the wealth of apparatus in the college and museum, and the practical work which it alone renders possible.

The number of science teachers who have thus attended the summer courses reaches 6,200, but as many of these have attended more than one course, the number of separate persons is not so large.

RESEARCH.

From time to time balances arise in the scholarship fund owing to some of the national scholarships or royal exhibitions being vacated before the full time for which they are tenable has expired. Scholarships are formed from these balances and awarded among those students who, having completed the full course of training for the associateship, desire to study for another year at the college. It is understood that the fourth year is to be employed in research in the subject of the associateship.

The gaining of one of the remanent scholarships, not more than two on the average annually referred to, furnishes really the only means by which deserving students are enabled to pursue research in the college; as, although a professor has the power to nominate a student to a free place in his laboratory, very few of the most deserving students are able to avail themselves of the privilege, owing to want of means.

The department only very rarely sends students up as teachers in training for research work, but only those who intend making teaching their profession are eligible for these studentships.

I trust that at some future day, when we get our new buildings—it is impossible to do more than we do till we get them—more facilities for research may be provided, and even an extension of time allowed for it if necessary. I see no reason why some of the 1851 exhibition scholarships should not be awarded to students of this college, but to be eligible they must have published a research. Research should naturally form part of the work of the teachers in training who are not brought up here merely to effect an economy in the teaching staff.

Such, then, in brief, are some of our normal school attributes. I think any one who knows the facts must acknowledge that the organization has justified itself not only by what it has done, but also by the outside activities it has set in motion. It is true that with regard to the system of examining school candidates by means of papers sent down from London, the department was anticipated by the College of Preceptors in 1853, and by Oxford and Cambridge in 1858; but the action of 1861, when science classes were open to everybody, was copied by Oxford and Cambridge in 1869. The department's teachers got to work in 1860, but the so-called "University Extension Movement" dates only from 1873, and only quite recently have summer courses been started at Oxford and Cambridge.

The chemical and physical laboratories, small though they were in the department's schools, were in operation long before any practical work in these subjects was done either at Oxford or Cambridge. When the college laboratories began about 1853, they existed, practically, alone. From one point of view we should rejoice that they are now third rate. I think it would be wrong of me not to call your attention to the tenacity, the foresight, the skill, the unswerving patience, exhibited by those upon whom has fallen the duty of sailing the good ship "Scientific Instruction," launched, as I have stated, out upon a sea which was certain from the history I have brought before you to be full of opposing currents.

I have had a statement prepared showing what the most distinguished of our old students and of those who have succeeded in the department's examinations are now doing. The statement shows that those who have been responsible for our share in the progress of scientific instruction have no cause to be ashamed.

CONCLUSION.

I have referred previously to the questions of secondary education and of a true London university, soon, let us hope, to be realized.

Our college will be the first institution to gain from a proper system of secondary education, for the reason that scientific studies gain enormously by the results of literary culture, without which we can neither learn so thoroughly nor teach so effectively as one could wish.

To keep a proper mind-balance, engaged as we are here continuously in scientific thought, literature is essential, as essential as bodily exercise, and if I may be permitted to give you a little advice, I should say, organize your athletics as students of the college, and organize your literature as individuals. I do not think you will gain so much by studying scientific books when away from here as you will by reading English and foreign classics, including a large number of works of imagination; and study French and German also in your holidays by taking short trips abroad.

With regard to the university. If it be properly organized, in the light of the latest German experience, with complete science and technical faculties of the highest order, it should certainly insist upon annexing the school of mines portion of our institution; the past history of the school is so creditable that the new university for its own sake should insist upon such a course. It would be absurd, in the case of a nation which depends so much on mining and metallurgy, if these subjects were not taught in the chief national university, as the University of London must become.

But the London University, like the Paris University, if the little history of science teaching I have given you is of any value, must leave our normal college alone; at all events till we have more than trebled our present supply of science teachers.

But while it would be madness to abolish such an institution as our normal school, and undesirable if not impossible to graft it on the new university, our school, like its elder sister in Paris, should be enabled to gain by each increase in the teaching power of the university. The students on the scientific side of the Paris school, in spite of the fact that their studies and researches are looked after by fourteen professors entitled maitres de conférences, attend certain of the courses at the Sorbonne and the Collége de France; and this is one of the reasons why many of the men and researches which have enriched French science hail from the Ecole Normale.

One word more. As I have pointed out, the French Ecole Normale was the result of a revolution. I may now add that France since Sedan has been doing, and in a tremendous fashion, what, as I have told you, Prussia did after Jena. Let us not wait for disastrous defeats, either on the field of battle or of industry, to develop to the utmost our scientific establishments and so take our proper and complete place among the nations. J. NORMAN LOCKYER.

ANEROID BAROMETERS.

By C. F. MARVIN, Professor of Meteorology.

THE unreliability of aneroid barometers when anything like accurate measures of pressure are required is almost proverbial. It is evident that much work remains to be done in order to ascertain the laws governing the irregular action of this most convenient and, in some cases, indispensable type of barometer. It will be still better if we can ascertain and eliminate the real causes of the anomalous behavior. The face reading of an aneroid, even when not compensated for temperature, is often thoughtlessly accepted with every confidence as to its infallibility, but it is pretty generally understood among the more critical observers that aneroids require to be frequently checked and verified by comparison with standards, and that a slow change goes on within them after they have been subjected to a considerable change in air pressure.

It may be stated that, broadly classified, the inherent errors of all aneroids are of two kinds. When the instrument is exposed over long periods to only such pressure changes as occur at any station at the earth's surface from day to day, its error will remain sensibly constant for a considerable period of time, but from time to time relatively large changes may and generally do take place in this error without any apparent cause, and cannot, therefore, be duly allowed for. The other inherent error is an effect connected with any considerable change in pressure. Suppose, for example, the pressure is changed in a short space of time from 30 to 25 inches; at the instant the pressure becomes stationary the index of the aneroid will show a certain reading, but instead of remaining stationary with the pressure, it continues moving slowly downward over the scale, showing a lower and lower reading as time progresses. This after effect is called "creeping;" it is analogous to the slow change in the zero of a thermometer, and varies greatly under different circumstances, and has been observed to increase during several days or even weeks. Its amount in a given barometer depends, among other things, upon how much and how rapidly the pressure has changed and whether the change was continuous or not. Finally, if the pressure is restored to its initial value, the index will fail to return immediately to the original reading, but will slowly creep toward it. These errors are separate and distinct from errors of graduation, or the effects of temperature and friction, or those depending upon what position is given the aneroid, all of which latter can be more or less perfectly disposed of. From the foregoing it necessarily follows that the readings carried up and down mountains or sent up with kites and balloons are subject to a series of errors which it is practically impossible to determine with any degree of exactness.

A most valuable series of experiments upon the aneroid has been published by Dr. C. Chree, Superintendent of Kew Observatory, whose paper on this subject, entitled Experiments on Aneroid Barometers at Kew Obervatory and their discussion, has recently appeared in Philosophical Transactions, series A, vol. cxcv., 1895. The author's object, as he states, is "to acquire knowledge likely to increase the usefulness of the aneroid under the conditions in which it is actually employed."

In the execution of this object the tests of hundreds of aneroids, made during many years for the makers, at the Kew Observatory, were exhaustively discussed and other special tests were made to develop the law of the after effect or creep. Dr. Chree's analysis is most comprehensive and complete, and leaves little to be desired, but, in the present writer's estimation, the fair conclusion to be drawn from the investigation is that the errors of all ordinary aneroid barometers are hopelessly involved in a complex law, so that under the complex conditions of use it is impossible, or at least impracticable, to satisfactorily predict or determine the errors of a given instrument. Among other writers on this question may be mentioned Lovering, Proceedings American Academy of Sciences, 1849, vol. ii.; also American Journal of Science, 2d series, vol. ix., p. 249: Balfour Stewart, B.A., Report, 1867; also Proceedings Royal Society, vol. xvi., 1869; Philosophical Magazine, vol. xxxvii., 1869: Whymper, How to Use the Aneroid, John Murray, 1891, and Carl Barus, American Journal of Science, vol. i., 4th series, 1896.

Lovering, Stewart, and Whymper may be said to have observed and recorded the facts relative to the errors of aneroids. Dr. Chree has gone a step further and formulated the approximate law of error. Unfortunately, this law appears to be too complex and involved to become practically useful. What will still remain to be done is to definitely ascertain the cause of the difficulty, and if this cannot be quite largely eliminated by an improved construction, we must then invent some new and better type of instrument. A step in this direction has been taken by Prof. Carl Barus, whose counter-twisted curl aneroid, he claims, is practically free from the after effect and similar errors common to other forms of aneroid. The experimental forms investigated by Prof. Barus are very delicate pieces of laboratory apparatus, and are scarcely available for practical work. The "counter-twisting" is, however, a new feature, and may yet prove to be of great value in practical instruments.

The present writer has given some thought to this problem from time to time, but no opportunity has been offered for making any new investigations. It seemed to me that the real seat of the greater part, if not all, of the after effect or creeping is in the corrugated aneroid vacuum boxes themselves, as distinguished from the tempered steel springs that are employed to keep the box from collapsing under the pressure of the air. This conviction was forced upon my mind after reading Mr. Whymper's valuable paper on the errors of the aneroid, and in 1892 I made the following simple experiment, which greatly confirmed this supposition: The vacuum box of an old aneroid was removed and a heavy weight (a trifle over 50 pounds was required) was applied directly to the steel spring, thereby straining it as nearly as possible to the same extent as did the air pressure exerted through the medium of the corrugated vacuum box. Any desired changes in the position of the index were made by appropriate changes in the weight. No after effect comparable in magnitude with that exhibited by ordinary aneroids was ever observed. In other words, this tempered steel spring behaved to all intents and purposes as if it were a perfectly elastic body. Readings of the pressure scale could be made corresponding to about 0·005 of an inch on the barometer. A careful or full investigation was not attempted. I believe, nevertheless, that the tempered steel springs employed in all aneroids are or may easily be made to be highly trustworthy. On the other hand, the process of constructing the vacuum boxes is well calculated to develop therein irregular and imperfect elastic properties in the highest degree. The top and bottom surfaces are each formed of a thin circular sheet of metal, with a narrow rim bent up around the edge. In order to give flexibility several concentric corrugations are formed over quite the whole face of the disk. The crimping and bending operations necessary in the manufacture of these corrugated disks have a marked effect upon the elastic qualities of the metal, which, to make matters worse, is generally of brass, German silver, or some similar alloy well known to be only

imperfectly elastic under the most favorable conditions. The metal must originally be more or less in a soft and annealed condition in order to withstand the corrugating and bending operations. Those portions which are stretched and compressed by the process become stiffer and more elastic and the finished disk is permeated by a most complex and irregular system of internal strains. The arrangement of molecules is undoubtedly a highly unstable one, and it is not surprising that large, discontinuous, and unexpected changes take place in the readings of the finished instrument.

In 1896 I had occasion to design a meteorograph suitable for use on the kites recently employed by the Weather Bureau in making aerial observations. The lightest possible form of barometer of the aneroid type was an obvious necessity. The considerations outlined above led me to substitute steel in place of brass for the vacuum boxes, and a preliminary effort was made to profit if possible by the results brought out by Prof. Barus. Mechanical difficulties in securing a satisfactory form of recording aneroid on these lines forced me, however, to abandon this attempt at the time and adopt a type of instrument similar to the well-known Richard barograph. The vacuum boxes were made of steel instead of composition metal. The performance of these barometers, although better generally than brass instruments, has disappointed my expectations, as they have exhibited considerable after effect, which I am still convinced is due primarily and largely to the imperfect elastic properties of the boxes themselves. Boxes of small diameter were necessarily adopted, but these are inferior to those of large diameter. In support of this statement I find a very significant note in Dr. Chree's paper, p. 446, stating that the after effect in 30 barometers of special make and large size (how large is not stated), as tested at Kew, was so exceptionally small that he found it necessary to multiply the actually observed effects by seven in order to make the figures similar in size to corresponding results from ordinary aneroids.

In concluding these remarks attention is called to a certain source of error in testing aneroids that does not appear to have been mentioned hitherto, and, if not noticed or guarded against, may have an appreciable effect on results. Any sudden change in the air pressure under the receiver of a pump inevitably heats or cools the gas dynamically, in consequence of which there is a most pronounced and real "after effect" in the pressure of the air within the receiver. In my own experience I have been very greatly surprised at the slowness with which the gas acquires its stationary temperature and the magnitude of this effect on the resulting stationary pressure. The slow rate of pressure change adopted by Dr. Chree, namely, one inch in five minutes, in all probability eliminates any error of this kind, but the point is not mentioned, and it is just possible that the results of the older observations and of investigations made without due regard for this effect may be somewhat in error in consequence.—Monthly Weather Review.

OZONE AND THE PHENOMENA OF PHOSPHORESCENCE.

A STROLLER upon the sea beach at night, after a storm has occurred, will notice that the atmosphere is pervaded with a pungent odor and that the crests of the waves are slightly illuminated, while glimmering lights flit over the water like fitful will-o'-the-wisps. What is the origin of these? To what cause must we attribute them? The question is very easily answered when it is a question of those animalcules, those microscopic "lamps of the sea" that the ocean cradles by millions upon millions, and that many a navigator has met with in certain parts of the Atlantic, especially off the coast of Guinea and toward the Cape.

But let us filter this luminous water, and if we do not succeed in collecting any living being carrying the pale light by which the waves are illuminated, we shall be very much perplexed. The solution of the question, however, is very simple, and mere accident has led us to find it.

It is from the ozone found in the air that we must demand the key of the mystery. Let us, in fact, take a closed glass cylinder (Fig. 2, No. 2) provided with two cocks and fill it with air or ozonized oxygen; and then let us add to the latter about a fifth of its volume of sea water. If we place the apparatus in darkness and shake it energetically, we shall observe in the tube a bright light that will persist for several seconds, and which, like that of the waves, will disappear and again exhibit itself upon a new agitation, and finally vanish completely.

We can, if we wish, produce a continuous luminosity by using a water tromp (Fig. 2, Nos. 1 and 3) and arranging the experiment as shown in Fig. 1. To the left is the ozone generator, *O*, consisting of an entirely new apparatus, and which is actuated by a transformer, *T*. The tromp, *E*, sucks directly into the ozonizer the air led by a conduit, *C*. The light produced has its origin at the surface of separation of the cones (as is clearly shown in Fig. 2, Nos. 1 and 3), at the point where the water and ozone come into contact. The water preserves its light for five or six seconds after its exit from the tromp, and may be collected in a tank. When projected upon the floor, it falls in a stream of fire and spreads vapors of a milky aspect that are somewhat analogous to those of phosphorus.

It therefore results from these experiments that, in the absence of animalcules, the phosphorescence of the ocean is due to the action of ozone.

What is the exact cause of the phenomenon?

M. Fahrig, from experiments made with water only, concludes that the luminosity is due to the energy absorbed by the ozone at the time of its formation, but confesses that he knows of nothing in the way of proof or probability to support such a hypothesis. There is nothing in this. The luminosity produced is caused simply by the energetic oxidation of certain organic substances contained in the water. Even with very concentrated ozone, pure water gives rise to no phenomenon of phosphorescence.

Milk, urine, benzene, thiophene, and alcohol give rise with ozone to phenomena that are analogous to those which occur with water. The brightness of the light produced varies with the nature of the bodies that enter into reaction.

It is interesting to make evident the very energetic and powerful action that ozone exerts upon impure water, at a time when a dearth of spring water in entire France, and especially in Paris, is causing so legitimate an excitement.

The purification of water by ozone will probably be the solution of the grave problem that is now occupying the attention of our hygienists.—La Nature.

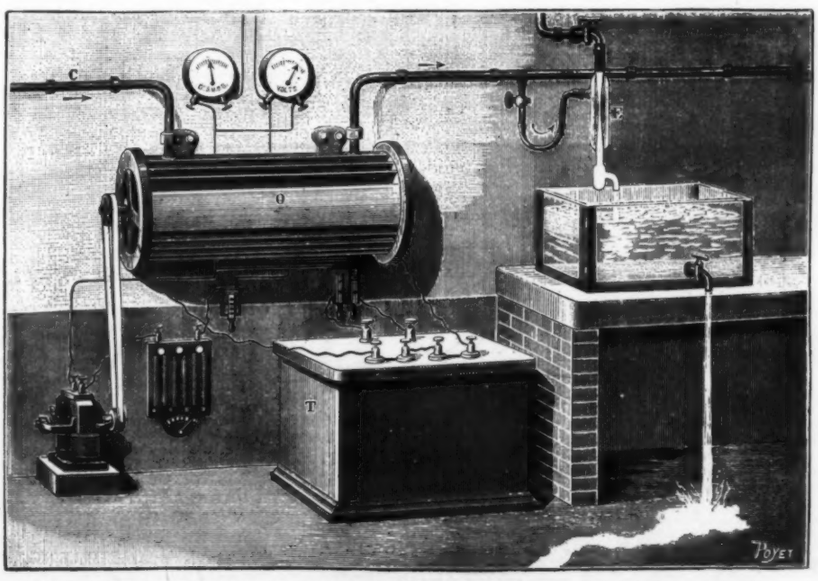


FIG. 1.—ARRANGEMENT OF APPARATUS FOR THE REPRODUCTION OF THE PHENOMENON OF THE PHOSPHORESCENCE OF THE OCEAN.

SOME THOUGHTS ON RETARDING THE CHANGES OF OLD AGE.

By ALBERT SEITZ, M.D., McMinnville, Tenn.

IN the study of living forms, from the protozoa to the mammals, and from the protophytes to the seed plants, we find certain changes and conditions characteristic of old age. In the human subject the principal changes which we note are atrophic and degenerative in their nature. The muscles and glands are the parts more especially involved in senile atrophy, although other soft parts are affected to some extent. There is a diminution in size of the cellular elements, though without involving any essential change in their structure. The muscular fibers become small and are said to take on more uniformity of size, while the spleen and lymphatic glands undergo a remarkable diminution in weight and size, which increases as age advances. There is also some shrinking in volume of the glandular structures of the digestive tract. Wherever fat has accumulated it gradually wastes away. It is said that atrophy begins to take place before degeneration commences. Pigmentary and fatty infiltrations of the elements are common, as are also calcareous incrustations. As an instance of the location of this fatty degeneration, muscular fibers, both voluntary and involuntary, might be mentioned. It is also found in blood-vessels, especially the terminal arteries of the brain, and to some extent in the nerve cells and in the parenchyma of glandular organs. Pigmentary infiltration, it is claimed, is not so frequently met with as is fatty infiltration. In the pineal gland, in ligaments, cartilages, tendons, and the walls of arteries, calcareous deposits are common. In the brain and spinal cord the neuroglia increases until it frequently predominates over the nervous element, and there is a tendency to the deposition of amylaceous bodies in these parts. The fatty elements of the brain are diminished, while the water and phosphorus are increased in quantity. The height and weight of the body on account of these changes are diminished, the body as a whole being shorter and lighter, while its individual parts are also lessened in size, with the exception of the heart and kidneys. The heart, as a rule, is hypertrophied, while the kidneys are at least the size they were in middle life. Changes take place in the skin, rendering it dry and wrinkled, the hair becomes thin and white, the teeth drop out, the body bends. These changes induce a general decrease in vigor; the power of the muscles is lessened; the combustion going on in the body is diminished, as is shown by a decrease in the amount of carbonic-acid gas exhaled. The vital capacity of the lungs is decreased, although there is a quickening of the respiratory rhythm. The pulse rate rises, the secretions are diminished, and the quantity of urine is less. Such, briefly stated, are some of the characteristics of old age. This period of life is more liable to certain diseases, as those due to arterio-sclerosis, to certain forms of rheumatism and gout, and so on.

What produces these changes in the body which drag us down to the grave? Is there no way to retard or prevent them? If we could obviate them even in a measure, how great would be the benefit, and with what rejoicing would the earth's inhabitants hail the discovery, especially those among them who have begun to enter the shadows which gather about life's evening! In the cycle through which a portion of the material world revolves, from the organic to the inorganic, from the living to the dead and back again to the living, it would appear that, as old age approaches, the material of the animal body takes on more and more the nature of the inorganic and becomes more and more akin to the mineral world. When an individual starts in life, he appears to be endowed with a certain power or ability to maintain his status in the highly organized animal world, and to resist largely the tendency of his tissues to become in their chemical nature more nearly akin to the mineral kingdom. What this power consists in I do not know; but it seems to be greatly impaired by age. Now, if by introducing into the body certain agents which might render the excess of accumulating mineral matter more soluble, so that it could be more easily eliminated from the body, we might get rid of one element that contributes largely to the deterioration and degeneration that come with old age. Again, all animal and vegetable tissues when young possess in a large measure

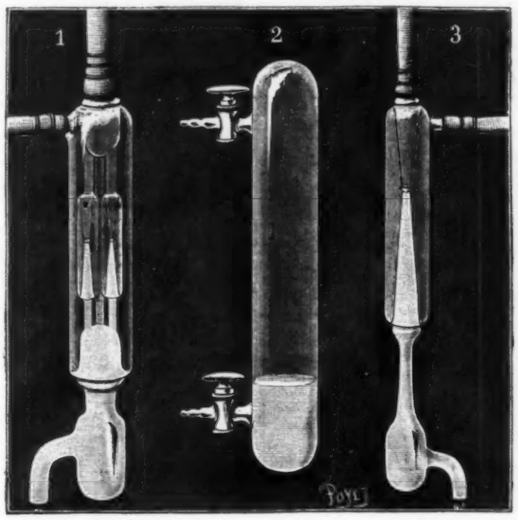


FIG. 2.—VARIOUS EXPERIMENTAL APPARATUS.

1, tromp with three tubes; 2, ozone cylinder; 3, ordinary tromp.

this resistance toward the changes that take place in senility. Then why would it not be a feasible and rational idea for those who are approaching the period of life when senile changes begin to make their appearance to take as nourishment only the tissues of young animals and vegetables, and thereby supplement their waning power of resistance with that of those organisms which contain it in abundance? And, also, as we now have a process of treating certain diseased conditions of different organs of the body with the products of the corresponding organs of animal bodies (and I believe with some success), why could benefit not be derived by administering the quintessence of the organs of young and healthy animals to those whose bodies are beginning to show the effects of age, and in that way furnish them artificially with the power to resist the encroachments of time? Two or three times a year, for instance, we might administer this treatment for a week or two at a time; and who can say that we might not retard in this way the capture of life's citadel by the king of the glass and scythe?—Medical Record.

ANCIENT TREPANNING.

THE curious custom of trepanning—that is, of removing small pieces of bone from the living head—is very ancient and widely spread, says Nature. In his recently published book, "Prehistoric Problems," Dr. Munro has devoted a chapter to "Prehistoric trepanning and cranial amulets." About the same time, Drs. H. Malbot and R. Verneau published in L'Anthropologie (tome vii.) a memoir on the Chaouias and the trepanning of the skull in the Aurès. The Djebel-Aurès, "Mountains of the Cedars," form the southeast border of the Algerian plateau; here and in the neighboring Djebel-Chechar is the center of trepanning. The natives are carefully described; they belong to the Berber stem; a portion—perhaps one-eighth—are fair; thus the external, as well as the cranial, characters show them to be a somewhat mixed people. The method of trepanning is very fully described, and a native doctor showed Dr. Malbot a skull with over a dozen circular holes, two slits, and a large irregular orifice, all of which had been pierced when the man was alive! The skull, though taken from a grave, was kept hidden, and it evidently was used as an example by the local doctors. The enthusiastic French doctor says, "The Chaouias respect their tombs, and on no pretext will rifle them; the love of science alone can explain this profanation on the part of our trepanner. It is the same sentiment which has led to our possession of the specimen." Dr. Malbot describes how he acquired the specimen which is now in the Museum d'histoire naturelle in Paris. The natives have recourse to trepanning for blows or wounds on the head; it does not matter how long before the blow may have been given, if only a sick person can remember that he has had one. The operation is by no means a severe one, as the people have a most remarkable recuperative constitution. A woman, tired of the conjugal yoke, has been known to call in the services of a trepanner in order to procure a divorce from her husband by producing a piece of her skull, which she affirmed had been broken by his ill treatment.

THE POWER OF WOOD SAWS.

PROF. O. G. DODGE has recently made some tests in order to determine the power required to drive woodworking machinery at the navy yard in Washington. With a circular rip-saw, 28 inches in diameter and running at 1,200 revolutions per minute (or 8,800 lineal feet per minute) and ripping seasoned hard oak 7⅝ inches thick, with a feed of 10 feet per minute, 18·8 mechanical horse power was used. The motor and saw running idle absorbed 2·1 horse power. In other tests with rip-saws of 24 inches, 14 inches and 12 inches in diameter, and at varying speeds of from 1,500 to 2,000 revolutions per minute, the mechanical horse power output ranged from 2·6 to 8·9 horse power. A band-saw running at 160 revolutions per minute (or 3,017 lineal feet per minute) required 10¼ mechanical horse-power when the motor was running idle. When ripping seasoned ash 10¾ inches thick with a feed of 6 feet per minute, but 14·8 horse power was consumed. In ripping yellow pine 12 inches thick and running 20 feet per minute, 17·6 horse power was consumed. A contrast was afforded by the work done by a band-saw having a pulley 28 inches in diameter and running 480 revolutions per minute. With a belt pulley 12 inches in diameter and 3⅛ inches face and with the motor belted to the saw shaft the motor consumed 0·9 horse power when running idle, and but 1·3 horse power when ripping seasoned oak 3 inches thick and with a speed in one case of 2½ feet per minute and in the other cases of 4 feet per minute, the difference in speed apparently making no difference in the consumption of power.—Industries and Iron.

Schweinfurt, in Bavaria, is the seat of the largest manufacture in Europe of steel balls for bicycle bearings. The two factories owned by one firm there produce annually 2,000,000 gross, with 600 men working ten hours a day. Since 1896 a fierce competition has sprung up in this trade, owing to the large profits made by this firm, as will be seen from the following figures: The factories for making steel balls in Germany increased from five in 1896 to twenty-five in 1897 and the production rose from 1,500,000 to 4,500,000 gross. The factories in France increased in the same time from four to fourteen, and the production from 300,000 to 500,000 gross. Those in England increased from four to seven factories, and the production from 250,000 to 500,000 gross. The weekly hours of labor are sixty, sixty-six, and fifty-two in Germany, France, and England respectively. Lately, too, the United States has exported steel balls to Germany, as well as to England, which has seriously affected Germany's export in these commodities to England, and owing to the overproduction, prices have fallen by 65 per cent., while materials and labor, etc., have risen by 38 to 42 per cent. since 1896. At present, 95 per cent. of the steel balls are used for bicycles, so the future of the trade depends greatly on their utilization as well as for other mechanical purposes and machinery. The "Automatic" Steel Ball Company, at Schweinfurt, exported $35,000 worth of steel balls to England in 1897.

NOW READY.

SPIRIT SLATE WRITING and KINDRED PHENOMENA.

By W. E. ROBINSON,
"Man of Mystery."

153 Pages. 66 Illustrations. Price $1.00 Postpaid.

The author is a well known authority on magic art, with which he has been identified for the past twenty-five years. From childhood he has been accustomed to seeing prominent prestidigitateurs, both at home and abroad, and he has been able to gather many valuable secrets from them. Many of his ideas have been utilized by American conjurers. For many years he was the right-hand man of the late Alexander Herrmann, and was also associated with Kellar. He was the original exponent of "Black Art," "Astarte," "Out of Sight," and kindred novelties. He has made it a study of his lifetime to acquaint himself with the methods employed by mediums to dupe their victims, and on this account the work is of standard value. In addition to the chapters on slate writing, mind reading, etc., a chapter on "Miscellaneous Tricks" has also been added.

☞ *Send for illustrated circular and full table of contents.*

1898 EDITION.

EXPERIMENTAL SCIENCE.

By GEO. M. HOPKINS.

Twentieth Edition, Revised and Enlarged. 914 Pages. 820 Illustrations. Elegantly bound in Cloth. Price, by mail, postpaid, $4.00; Half Morocco, $5.00.

This is a book full of interest and value for teachers, students and others who desire to impart or obtain a practical knowledge of Physics.

This splendid work gives young and old something worthy of thought. It has influenced thousands of men in the choice of a career. It will give anyone, young or old, information that will enable him to comprehend the great improvements of the day. It furnishes suggestions for hours of instructive recreation.

What the Press says of "Experimental Science."

"Mr. Hopkins has rendered a valuable service to experimental physics."—*Evening Post.*

"The book is one of very practical character, and no one of a scientific turn of mind could fail to find in its pages a fund of valuable information."—*Electric Age.*

"The work bears the stamp of a writer who writes nothing but with certainty of action and result, and of a teacher who imparts scientific information in an attractive and fascinating manner."—*American Engineer.*

"It should be found in every library."—*English Mechanic.*

"The book would be a most judicious holiday gift."—*Engineering and Mining Journal.*

Mr. Thomas A. Edison says: "The practical character of the physical apparatus, the clearness of the descriptive matter, and its entire freedom from mathematics, give the work a value in my mind superior to any other work on elementary physics of which I am aware."

Prof. D. W. Hering, University of the City of New York, says: "I know of no work that is at the same time so popular in style and so scientific in character."

Prof. W. J. Rolfe, of Cambridgeport, Mass., writes: "The book is by far the best thing of the kind I have seen, and I can commend it most cordially and emphatically."

Hundreds of cordial recommendations from eminent Professors and Scientific men.

Send for Illustrated Circular and Table of Contents.

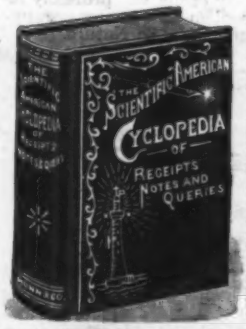
THE SCIENTIFIC AMERICAN

CYCLOPEDIA of RECEIPTS, NOTES and QUERIES

EDITED BY ALBERT A. HOPKINS.

12,500 Receipts, 708 Pages.

Price, $5 in cloth; $6 in sheep; $6.50 in half morocco; Postpaid



This splendid work contains a careful compilation of the most useful Receipts and Replies given in the Notes and Queries of correspondents as published in the SCIENTIFIC AMERICAN during the past fifty years; together with many valuable and important additions.

Over twelve thousand selected receipts are here collected; nearly every branch of the useful arts being represented. It is by far the most comprehensive volume of the kind ever placed before the public.

The work may be regarded as the product of the studies and practical experience of the ablest chemists and workers in all parts of the world; the information given being of the highest value, arranged and condensed in concise form, convenient for ready use.

Almost every inquiry that can be thought of, relating to formulæ used in the various manufacturing industries, will here be found answered.

Those who are in search of independent business or employment, relating to the home manufacture of salable articles, will find in it hundreds of most excellent suggestions.

A COMPLETE

ELECTRICAL LIBRARY

By PROF. T. O'CONOR SLOANE,

Comprising five books, as follows:

Arithmetic of Electricity, 138 pages	**$1.00**
Electric Toy Making, 140 pages	**1.00**
How to Become a Successful Electrician, 189 pp.	**1.00**
Standard Electrical Dictionary, 682 pages	**3.00**
Electricity Simplified, 158 pages	**1.00**

☞ The above five books by Prof. Sloane may be purchased singly at the published prices, or the set complete, put up in a neat folding box, will be furnished to Scientific American readers at the special reduced price of **Five dollars.** You save $3 by ordering the complete set. **Five volumes, 1,500 pages, and over 450 illustrations.**

☞ Send for full table of contents of each of the books.

☞ Our complete book catalogue of 116 pages, containing reference to works of a scientific and technical character, will be sent free to any address on application.

MUNN & CO., Publishers, 361 Broadway, N. Y.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.

PAGE

I. BOTANY AND HORTICULTURE.—Bignonia Purpurea.—1 illustration 19274

II. ELECTRICITY.—A Design for an Electric Launch Motor.—By CHARLES T. CHILD.—19 illustrations 19283
Behavior of Air Under Great Electrical Stress 19274
Damage to Italian Shipping by Galvanic Action 19268
Electrical and Engineering Work in the Navy During the War.—By W. D. WEAVER 19266

III. MECHANICAL ENGINEERING.—Acetylene for Gas Engines.. 19272
A New Gasoline Motor.—1 illustration 19266
The First Elevator 19273
The Longdon Gas Engine.—2 illustrations 19267
The Power of Wood Saws 19278

IV. MEDICINE.—Some Thoughts on Retarding the Changes of Old Age.—By ALBERT SEITZ 19277
Ancient Trepanning 19278

V. METEOROLOGY.—Aneroid Barometers.—By C. F. MARVIN 19276

VI. MISCELLANEOUS:
Miscellaneous Notes 19269
Engineering Notes 19269
Selected Formulæ 19269

VII. NAVAL ENGINEERING.—Waste Heat at Sea 19272

VIII. OPTICS.—The Ives Chromoscope.—1 illustration 19272

IX. ORDNANCE.—The Tactical Applicability of the Maxim Gun.—By Lieut.-Gen. A. v. BOGUSLAWSKI 19268

X. PHYSICS AND CHEMISTRY.—Ozone and the Phenomena of Phosphorescence.—2 illustrations 19277

XI. RAILWAYS.—The Central London Railway.—1 illustration 19267

XII. SCIENCE.—A Short History of Scientific Instruction.—II 19275

XIII. TECHNOLOGY.—Improvements in Bronze Casting 19272
Peanuts and Peanut Oil 19274
"Sodor."—4 illustrations 19273
The Saint Gobain Plate Glass Manufactory.—5 illustrations 19270

XIV. TRAVEL AND EXPLORATION.—The Micronesian Venice.. 19274

XV. TRICKS.—The "Secret of the Harem."—1 illustration 19275

SPECIAL NAVAL SUPPLEMENT No. 1165

contains a historical review of the modern United States navy, the classification of the various forms of war vessels and nearly one hundred illustrations, including details of construction of such vessels not found in any other publication. A map of Cuba printed in five colors accompanies it. Price, 25 cents. Single copies sent by mail in United States, Canada and Mexico. Foreign countries, 8 cents extra.

MUNN & CO., 361 Broadway, New York.

THE SCIENTIFIC AMERICAN

Army and Coast Defence Supplement

It treats of guns and gun carriages for Army and Navy use and Coast Defence, including disappearing gun carriages, rapid fire guns, machine guns, mortars, etc., with special reference to their construction and operation. The subject of projectiles, powders, gun cotton, etc., is also fully treated; range finders, torpedoes, submarine mines and armor are all fully described and illustrated. There is also a section devoted to the small arms of the Army and Navy, together with an account of the organization of the Army, with fine engravings of prominent Generals. Never before have these subjects been treated in such a popular way. The illustrations number over 100 and include a magnificent double page Supplement of our largest battleship, the "Iowa." The whole is enclosed in a handsome cover, showing a large coast defence gun in action.

Price by mail, 25 cents; to foreign countries, 35 cents.

MUNN & CO., Publishers, 361 Broadway, New York.

BUILDING EDITION

OF THE

SCIENTIFIC AMERICAN.

Those who contemplate building should not fail to subscribe.

ONLY $2.50 A YEAR.

Semi-annual bound volumes $2.00 each, yearly bound volumes $3.50 each, prepaid by mail.

Each number contains elevations and plans of a variety of country houses; also a handsome

COLORED PLATE.

SINGLE COPIES, - - - - 25 CENTS EACH.

MUNN & CO., 361 Broadway, New York.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had over *fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Trade Marks, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, on application containing full information about Patents and how to procure them; directions concerning Trade Marks, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases, Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York

BRANCH OFFICES.—No. 625 F Street, Washington, D. C.

SCIENTIFIC AMERICAN SUPPLEMENT. No. 1203

Copyright, 1899, by Munn & Co.

Scientific American, established 1845.
Scientific American Supplement, Vol. XLVII, No. 1203. NEW YORK, JANUARY 21, 1899. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THE DOWAGER EMPRESS OF CHINA.

THE recent events which have agitated the Celestial Empire have drawn attention to that queen who more than once has taken a preponderating part in the political affairs of her country.

Contrary to the general opinion, the empress is not the mother, but the aunt, of the young emperor.

Widow of the Emperor Tsien-Fung, who died in 1861, after having fled from the capital on the approach of the Anglo-French expedition, she took the reins of government during the minority of Tung-Chi, son of another wife of the king. In 1875, on the death of the sovereign, who had reigned only two years, she again directed the affairs of state during the minority of the actual emperor, son of a brother of her consort.

Since that period she has ever governed according to her whims. She has forced her will upon the Tsung-li-Yamen (ministry of foreign affairs) with an energetic determination, relying all the while upon the advice of Li Hung Chang. Many are the attempts which have been made to undermine her authority and her influence. Prince Kung, who died some months ago, was one of her bitterest opponents. Never has she been actually beaten, and the eclipses of her prestige have never lasted longer than one or two weeks.

She has always led a very busy life. She it was who reigned during the terrible Tai Ping rebellion and during the last war with France. Many are the stories, more or less mysterious, which are told of her. In truth, she leads a very secluded life. She, herself, selects the women of the sovereign's harem.—Le Monde Illustré.

THE DOWAGER EMPRESS OF CHINA—AFTER A CHINESE WATER-COLOR.

Rails in the United States have a knack of getting endworn, and therefore have to be removed from the line. Various methods of treatment have been tried for restoring them to usefulness. The latest is that of the Holland Company, of Pittsburg, who have laid down a plant for cutting off the ends and redrilling the rails. A sufficient length is cut off to remove any markings due to the old fishplates, so as to get a good bearing for the new ones. The rails are calipered and arranged in regard to height, being graded to $\frac{1}{16}$ inch in height, so that they go together well in the track. Rails which have been in service for fifteen years have been treated in this way and put back in the main track.

THE ALMANACS AND THE WEATHER BUREAU.

DURING the past few months the editor has noticed a number of newspaper paragraphs discussing the relative merits of the weather predictions published daily by the officials of the Weather Bureau for one or two days in advance and those published by the numerous "farmers' almanacs," published several months or even a year in advance, and sold in large numbers throughout the country. The predictions of the weather, as made by the Weather Bureau, are based entirely upon the daily maps that show the actual condition of the atmosphere, as reported by reliable observers throughout the country. On the other hand, the predictions in the various almanacs are founded upon a variety of principles, among which are the following:

1. The most conservative and rational almanacs are those that compile from the records of many past years a table showing what sort of weather has prevailed most frequently on the respective days of the year.

2. The least rational almanacs are those that pretend that the weather is controlled by planetary combinations and stellar influences, therefore, such predictions are properly said to be based upon astrology.

3. An intermediate class publishes predictions based upon the probability of spots on the sun, thereby assuming it to have been demonstrated that the solar spots control terrestrial weather.

4. The least scientific system of preparing the almanac predictions was explained to the editor many years ago by a gentleman whose almanac made the greatest pretensions to high scientific accuracy. This gentleman stated that on certain days he felt endowed with a certain ability or inspiration. These were his weather-making days, on which he sat down and with the most absolute confidence in the accuracy of his work wrote up the weather for the coming year, continuing at the work for a considerable time until the inspiration seemed to leave him, whereupon he necessarily stopped and delayed resuming the work until again filled with the spirit of divination.

Doubtless some almanac makers adopt a combination of the four preceding methods, but, in general, these seem to be the principles most widely recognized in the long range predictions of the almanacs, except only that in all cases the authors make free use of a system of general and rather indefinite terms that will apply just as well to a thunderstorm, a hurricane, or an earthquake. The warning "Look out for something very unusual about this time" is, of course, not a meteorological prediction, and not nearly as definite as the railroad signboard "Look out for the engine when the bell rings."

It must be acknowledged that the Weather Bureau has done wisely in abstaining from any attempt to make long range predictions, based upon any or all of the four methods above mentioned. The method that is actually used in its daily work has nothing of the absurd profundity of the astrological method, but is based upon the simplest common sense. The hope of the Bureau as expressed by Gen. Myer in 1871 still continues to be our earnest aim, namely, to so educate every citizen that he may take an intelligent view of the daily weather maps and learn to make his own local predictions.

In connection with meteorology in general, and especially weather predictions, there is a popular tendency to make a mistaken use of the word "science." Knowledge is science as distinguished from the world of imagination, which is fiction. Whatever is logical and true may be called scientific, but whatever is illogical or untrue is certainly not scientific. A map or a survey that gives us an exact picture of the true location of every spot on the earth's surface responds to scientific geography. A catalogue of all the plants and animals on the earth or of the stars in the sky constitutes a biological or an astronomical survey and is truly scientific. A series of maps of the weather at 8 A. M. daily is a scientific meteorological work, and any prediction of the weather that can be logically deduced from these maps is a scientific prediction. But a lot of predictions that are said to be deduced in defiance of sound logic and with a very imperfect knowledge of the laws of nature are fanciful fictions and not scientific, because they are contrary to all sound knowledge. Science can not possibly go contrary to the truth. Most scientific knowledge is so simple that it is taught in the schools to the children. There is not a child of the ten millions who attend our public schools who has not been taught that the stars and planets have no influence on human affairs. On the other hand, there are some fields of study that are so difficult that only a few have time and taste to devote to them. These may, if one pleases, be called the most profound depths of science, but they are perfectly accessible to every logical student, and a century hence this profound science will have become clear to all and will be taught in our schools just as we now teach that which was unknown in the time of Galileo and which is even yet untaught in the schools of Turkey and China.

In the preceding lines we have had in mind the average or normal American citizen, one that believes that two and two are four and that a straight line is the shortest distance between two points, and all the other axioms and principles of natural science. On the other hand, we must recognize the fact that there is quite an appreciable percentage of human beings who do not accept these principles. These are those who can demonstrate that the world is flat; that the earth does not revolve daily or annually; who believe in squaring the circle, in perpetual motion, the Keely motor, and other incongruities. The philosopher De Morgan has well styled this class of humanity as "paradoxers." They can assent to the truth of principles and facts that the rest of the world can never indorse; they belong to a different part of the universe from that world in which we live, to a place where white is black, where yes means no, where a part is greater than the whole, where time runs backward, where the material controls the spiritual. It is conceivable that the Creator may have created many distinct systems of worlds, and that the laws which obtain in our part of the universe do not hold good everywhere. The science that we are studying is simply the knowledge of the principles and the facts that belong to our part of the universe, where the "paradoxers" are entirely out of place.—Monthly Weather Review.

THE BRITISH WEATHER BUREAU.

IN the year 1896-97 the British forecasters scored a complete success in 54 per cent. of their prophecies, partial success in 27 per cent. of the cases, partial failure in 13 per cent., and complete failure in only 6 per cent. "Complete success," "partial success," and "partial failure," are vague phrases, which are not fully defined, though it is stated that partial success means that the forecast was correct at more than half the places of observation situated in the district in question, and a similar interpretation is to be applied to the term partial in the case of the failures. With such an explanation it must be admitted that looking to the difficulty of the problem involved, the result is highly creditable, says The Scotsman.

To the untrained observer the weather in England seems to be made at a moment's notice, while there is no sense of justice in its distribution; and though these forecasts only profess to give a few hours' warning, that warning is often well worth having. It is curious to notice that some districts seem to offer a much harder problem than others. In this respect the palm must be given to the west of Scotland, where complete success is attained in only 47 per cent. of the cases. On the other hand, the greatest certainty is in the South of England, where the forecasts are completely successful in 60 per cent. of the cases. During the last ten years or so there has been a slight but perceptible improvement in certainty. The improvement may be said to have taken the form of the conversion of partial success into complete success, and during the last four years the record of complete successes has been above the average for the whole period. In regard to what is perhaps its most useful function—the issue of warnings of gales—the office is, as might be expected, a still more certain tipster.

Of the total number of warnings issued, 467 in all, 67·7 per cent. were justified by subsequent gales and 23·8 per cent. by subsequent strong winds, leaving only 2·9 per cent. not justified. This is the lowest percentage of failure yet attained, and the improvement which has been effected may be gaged by the fact that in 1887 16·4 per cent. of the 472 warnings issued were not justified by events. In four cases there were gales for which no warnings were issued. In one case a deep depression advanced with such rapidity as to elude the vigilance of the observers; in another case a small depression suddenly deepened in an unexpected manner. Of the hay harvest forecasts issued, 88 per cent. were useful, and several of the recipients expressed satisfaction with their accuracy. On the whole, the prophetic record of the office is thus eminently creditable. Improvement is slow, but it seems to be sure, and if the time is still far off when our weather forecasters can speak in terms less ambiguous than those they often affect, it is satisfactory to find that if their prophecies are vague, they are yet safe.

It is announced that the German Navy Department has secured for "important technical purposes" 1,500 photographs of their new cruiser "Hertha" when traveling at a speed of nineteen knots. The photographs were taken in a few minutes by a new instrument, the cosmograph.

ACETYLENE.

By VIVIAN B. LEWES, Professor of Chemistry, Royal Naval College, Greenwich. Delivered November 21, 1898, before the Society of Arts and published in the Journal of the Society.

AT a meeting of the Royal Dublin Society in March, 1836, Edmund Davy, who was at that time professor of chemistry to the Society, first described acetylene gas and experimentally demonstrated some of its more remarkable properties. In the autumn of that year, at the Bristol meeting of the British Association, he read a paper upon it and the method of production, showing that when the metal potassium was made by heating a mixture of calcined tartar and charcoal in a large iron bottle, a black substance was frequently formed which was readily decomposed by water and yielded a gas which we now know as acetylene, but which he at that time christened bicarburet of hydrogen. It was in this paper that the author pointed out that, from the brilliancy with which the new gas burned in contact with the atmosphere, it was admirably adapted for the purpose of artificial light, if it could be produced at a sufficiently cheap rate.

Twenty years elapsed after Davy's discovery before any important addition was made to our knowledge of acetylene, and although Quet and Boettger made some observations on the formation of metallic acetylides in 1857, it was not until Berthelot's classical researches upon this compound, extending from 1859 to 1862, that anything was definitely known as to its true composition and method of formation.

It was Berthelot who showed that acetylene was formed during the decomposition of many organic substances by heat, and that ethylene, methane, alcohol, and ether, all yielded this compound when passed through heated tubes, and that it was, therefore, almost invariably found in the products of the destructive distillation of organic compounds, while he finally demonstrated the possibility of synthesizing acetylene by passing the electric current between carbon points in an atmosphere of hydrogen.

Acetylene has shared with many other bodies the troubles incidental to the constant changes of nomenclature which have occurred during the past century. Christened bicarburet of hydrogen by its discoverer, it soon after became known as klumene, while at a much later date the name acetylene was bestowed upon it, being derived from the hypothetical radical acetyle (C_2H_3), to which acetylene bears the same relationship as ethylene (C_2H_4) does to the radical ethyle (C_2H_5). It was also proposed at one time to give it the name of ethine, but the name which has survived the diseases common to incipient nomenclature is that of acetylene, by which it is now universally known.

On analysis this gas is found to contain:

Carbon	92·3
Hydrogen	7·7
	100·0

It has a density of 0·92, and when prepared by the action of water upon calcic carbide, it has a very strong and penetrating odor, but when the gas is thoroughly purified from sulphureted and phosphureted hydrogen, which are invariably present with it in minute traces, this extremely pungent odor disappears and the pure acetylene has a not unpleasant etherial smell.

Acetylene is readily soluble in water, which at normal temperature and pressure takes up a little more than its own volume of the gas, and yields a solution giving a purple red precipitate with ammoniacal cuprous chloride and a white precipitate with silver nitrate, these precipitates consisting of acetylides of the metals. The solubility of the gas in various liquids, as given by different observers, is:

100 Volumes of—		Volumes of Acetylene.
Brine	absorb	5
Water	"	110
Alcohol	"	600
Paraffin	"	150
Carbon disulphide	"	100
Fusel oil	"	100
Benzene	"	400
Chloroform	"	400
Acetic acid	"	600
Acetone	"	3,100

It will be seen from this table that where it is desired to collect and keep acetylene over a liquid, brine, i. e., water saturated with salt, is the best for this purpose, but in practice it is found that, unless water is agitated with acetylene, or the gas bubbled through water, the top layer soon gets saturated, and the gas then dissolves but slowly.

The great solubility of acetylene in acetone was pointed out by MM. Claude and Hess, who suggested charging acetone with the gas under pressure, a liter of acetone dissolving 360 times its own volume of the gas under a pressure of 12 atmospheres. On relieving the pressure the gas again escapes, and it was thought that this would prove a better method of storing the gas than liquefying it, but experiment has shown that acetone saturated in this way under pressure shares many of the disadvantages of liquid acetylene itself.

When acetylene was first introduced on a commercial scale, grave fears were entertained as to its safety, it being represented that it had the power of combining with certain metals, more especially copper and silver, to form acetylides of a highly explosive character, and that even with coal gas, which contains less than 1 per cent. of acetylene, such copper compounds had been known to be formed in cases where the gas distributing mains were composed of copper, and that accidents had happened from this cause. It was, therefore, predicted that the introduction of acetylene on a large scale would be followed by numerous accidents, unless copper and its alloys were rigidly excluded from contact with the gas. These fears, however, have fortunately proved to be absolutely unfounded, and the original gas fittings can be used with perfect safety with this gas.

In the summer of 1895 Mr. H. Gerdes, the chief engineer of Messrs. Pintsch, of Berlin, made an exhaustive series of experiments upon this point, not only with the gas under ordinary pressure, but with mixtures of acetylene with oil and coal gas at pressures of nearly 10 atmospheres.

This was done by placing the metals to be tested in steel cylinders, the slips being fitted in wooden frames so arranged as to prevent any contact either between the individual metals or the walls of the metal cylinder. Two of these cylinders were filled with pure acetylene, two with a mixture of 80 per cent. of acetylene and 20 per cent. of oil gas, and one with a mixture of acetylene with 20 per cent. coal gas, a small quantity of water being placed into each cylinder in order that the gas should be moist, as it was expected that this would greatly facilitate the action upon the metals. These cylinders were filled with the gases at a pressure of 9 to 10 atmospheres, and they were exposed on the roof of a shed from July 18, 1895, to April 9, 1896, this range of time exposing them to the highest temperature of an exceptionally hot summer, and the lowering of temperature incidental to a very cold winter.

Of all the metals and alloys used, those which are known to resist ordinary oxidation in the air remained perfectly unaffected, while the easily oxidizable metals suffered on the surface; but in no instance was it possible to trace any acetylene compound, and no explosion could be produced by either heating or hammering, while further experiments with acetylene, ammonia, and water showed clearly that such corrosion as had taken place by the simultaneous action of ammonia gas and acetylene was due exclusively to the action of the former gas, and no explosive compounds were formed.

If acetylene be passed through an ammoniacal solution of cuprous chloride, copper acetylide is formed, and when dry this explodes with great violence when struck or when heated, and independent observations, made by M. Bullier at about the same period, showed that in order to obtain this explosive compound of acetylene and copper, it was necessary that the gas should come in contact with a subsalt of the metal in the presence of excess of ammonia, and as in actual practice these conditions would never be realized, it is manifest that the alleged danger may be disregarded.

Acetylene shows some extremely interesting actions with regard to other metals. If acetylene be passed over red hot sodium or potassium, these metals burn in the gas with the formation of carbides, which, on being brought into contact with water, decompose with explosive violence, again setting free acetylene, while Moissan and Mourreu have made the interesting observation that with certain metals in the spongy condition, strong action takes place with acetylene, and that if this gas be passed over reduced iron which has been prepared at as low a temperature as possible, bright incandescence is produced, and carbon is copiously deposited and quickly chokes the tube, hydrogen at the same time appearing as a gaseous residue.

The second drawback that has always been urged against acetylene in its early days was that it was a highly poisonous gas, the researches of Bistrow and Liebreich having apparently shown that it acted upon the blood in the same way that carbon monoxide did to form a stable compound. Experiments upon the toxic action of gases, however, are open to considerable error, partly depending upon the method by which the gas has been prepared, and which will affect its purity, and partly upon the nature of the animals upon which the experiments are tried, rabbits and other rodents resisting the action of gaseous poisons like carbon monoxide far better than carnivorous animals, such as dogs, and it is impossible to argue from the action of the gas upon the one what the action will be upon the other, while it has not yet been made clear that the action upon either is a very safe index as to the action of the gas upon man.

Very extensive experiments, however, made by Drs. Grehant, Brociner, Malooz, Crismer, and others, all conclusively show that acetylene is much less toxic than carbon monoxide and, indeed, than coal gas.

Acetylene gas can be condensed into the liquid state by cold or by pressure, and the experiments by Ansell show that if the gas be subjected to a pressure of 21 53 atmospheres at a temperature of 9° C., it is converted into the liquid state, the pressure needed increasing, of course, with the rise of temperature, and decreasing with the lowering of the temperature, until, at 82° C., acetylene becomes liquid under ordinary atmospheric pressure.

The critical point of the gas is 37° C., at which temperature it requires a pressure of 68 atmospheres to liquefy it, while immediately that temperature is passed no pressure that could be brought to bear upon it will convert it into the liquid state. This phenomenon, which is common to all gases, of resisting all efforts to liquefy them above a certain temperature, was first investigated by Andrews, and the resolution of liquid acetylene into a gas on reaching its critical point can be very beautifully illustrated by taking a small tube half filled with the liquid and projecting an image of it upon the screen. On now gently warming the tube, the meniscus of the liquid, which at first was perfectly clear, is seen to flatten itself, and in a few minutes to entirely disappear as the temperature passes the critical point. On now removing the source of heat and allowing the tube to cool, as soon as the critical point is again reached on the downward scale, a violent storm of acetylene rain is seen to be going on in the tube as the gas condenses to the liquid state once more.

Long before the discovery by Wilson of the method of making calcic carbide on a commercial scale had placed acetylene at every experimentalist's disposal, acetylene had been liquefied by Cailletet, Andrews, and Ansell; but with the advent of calcic carbide, liquid acetylene assumed a position of commercial importance, and Messrs. Dickerson and Suckert, seeing the business possibilities, made it on a fairly large scale, and kept it in steel cylinders, while some time afterward Pictet also set up the manufacture of the liquid.

A great future was expected from its use in this condition, as a cylinder fitted with the necessary reducing valves would supply the gas to light a house for a considerable period, the liquid occupying between one four to five-hundredth the volume of the gas; but in the States and on the Continent, where liquefied acetylene was made on a large scale, several fatal accidents occurred, owing to its explosion under not easily explained conditions.

As a result of these accidents Berthelot and Violle made a very valuable research upon the explosion of acetylene under various conditions, and they found that if liquid acetylene in a steel bottle were heated at one point by a platinum wire raised to a red heat, the

whole mass decomposes and gives rise to such tremendous pressures that no cylinder would be able to withstand them, these pressures varying from 71,000 to 100,000 pounds per square inch. They, moreover, tried the effect of shock upon the liquid, and found that the repeated dropping of the cylinder from a height of nearly 20 feet upon a large steel anvil gave no explosion, but that when the cylinder was crushed under a heavy blow, the impact was followed, after a short interval of time, by an explosion; but this was manifestly due to the fracture of the cylinder and the ignition of the escaping gas, mixed with air, from sparks caused by the breaking of the metal, and a similar explosion will frequently follow the breaking in the same way of a cylinder charged with hydrogen at a high pressure.

Continuing these experiments, they found that in acetylene gas, under ordinary pressures, the decomposition brought about in one portion of the gas, either by heat or the firing in it of a small detonator, did not spread far beyond the point at which the decomposition started, but was local; while, if the acetylene was compressed to a pressure of more than 30 pounds on the square inch, the decomposition traveled throughout the mass and became in reality detonation.

These results showed clearly that liquefied acetylene was far too dangerous for general introduction for domestic purposes, as although the occasions would be rare in which the requisite temperature to bring about detonation would be reached, still, if this point were attained, the results would be of a most disastrous character; while the fact that several accidents had already happened accentuated the risk, and in this country the storage and use of liquefied acetylene is prohibited.

When liquefied acetylene is allowed to escape from the cylinder in which it is contained into ordinary atmospheric pressure, some of the liquid assumes the gaseous condition with such rapidity as to cool the remainder below the temperature of —90° C., and converts it into a solid snow-like mass.

Acetylene has the property of inflaming spontaneously when brought in contact with chlorine gas, and if a few pieces of carbide be dropped into saturated chlorine water, the bubbles of gas as they reach the surface spontaneously catch fire, while if a jet of acetylene be passed up into a bottle of chlorine it takes fire and burns with a heavy red flame, depositing its carbon in the form of soot. If chlorine be bubbled up into a jar of acetylene standing over water, a violent explosion, attended with a flash of intense light, and the deposition of carbon, at once takes place.

When acetylene is kept in a small glass holder exposed to direct sunlight, the surface of the glass soon becomes dimmed, and Mr. Bone has shown that when exposed for some time to the sun's rays it undergoes certain polymerization changes which lead to the deposition of a film of heavy hydrocarbons on the surface of the tube. It has also been observed by Cailletet and later by Villard that when allowed to stand in the presence of water a solid hydrate is formed.

Acetylene as has been shown is readily decomposed by heat, polymerizing under its influence to form an enormous number of organic compounds. Indeed, acetylene, which can itself be directly prepared from its constituents, carbon and hydrogen, under the influence of the electric arc, can thus really be made the starting point for the construction of an enormous number of different organic compounds of a complex character.

Acetylene in contact with nascent hydrogen builds up ethylene, ethylene acted upon by sulphuric acid yields sulphovinic acid, and this can again be decomposed in the presence of water to yield alcohol, while it has been proposed to manufacture sugar from this remarkable body. Picric acid also can be obtained from it by first treating acetylene with sulphuric acid, converting this into phenol by dissolving in potash and then treating the phenol with fuming nitric acid.

Acetylene is one of those bodies the formation of which is attended with the disappearance of heat, and it is for this reason termed an endothermic compound, in contradistinction to those bodies which evolve heat in their formation and which are called exothermic. Such endothermic bodies are nearly always found to show considerable violence in their decomposition, as the heat of formation stored up within them is then liberated as sensible heat, and it is undoubtedly this property of acetylene gas which leads to its easy detonation by either heat or a shock from an explosion of fulminating mercury when in contact with it while under pressure.

The observation that acetylene would be resolved into its constituents by detonation is due to Berthelot, who, by starting an explosive wave in acetylene by firing in it a charge of 0·1 gramme of mercury fulminate, succeeded in doing this. It has since been shown, however, that unless the gas is at a pressure of more than two atmospheres this wave soon dies out, and the decomposition is only propagated a few inches from the detonator.

If acetylene be heated in contact with air to a temperature of 480° C., it ignites and burns with a flame, the appearance of which varies with the way in which the acetylene is brought in contact with the air. With the gas in excess a heavy lurid flame emitting dense volumes of smoke results, while if the gas be driven out in a sufficiently thin sheet, it burns with a flame of intense brilliancy and almost perfect whiteness, by the light of which colors can be judged as well as by daylight.

The ignition point of the gas being below that of ordinary gas, it can be ignited by any red hot carbonaceous matter, such as the brightly glowing end of a cigar.

For its complete combustion a volume of acetylene needs approximately twelve volumes of air, and forms as its products of combustion carbon dioxide and water vapor. When, however, the air is present in much smaller ratio, incomplete combustion ensues, and carbon, carbon monoxide, carbon dioxide, hydrogen, and water vapor are produced. This is well shown by taking a cylinder one-half full of acetylene and one-half of air; on applying a light to this mixture a lurid flame runs down the cylinder and a cloud of soot is thrown up, the cylinder also being thickly coated with it and often containing a ball of carbon; on now waiting a few moments to allow some air to diffuse into the cylinder and again applying a taper, an explosion, due to a mixture of carbon monoxide and air, takes place.

It is probable that when a flame is smoking badly, distinct traces of carbon monoxide are being produced, but when an acetylene flame burns properly, the products are as harmless as those of coal gas, and, light for light, less in amount.

When acetylene is mixed with air, like every other combustible gas, it forms an explosive mixture. Observers differ somewhat as to the range between which mixtures of acetylene and air are explosive, Dr. Clowes stating that any mixture containing from 3 to 82 per cent. of the gas is explosive, while Dr. Bunte gives a rather lower range.

These discrepancies are probably due to differences in the method of igniting the mixture, and also as to what is to be taken as explosion. A light applied to a mixture containing 3 or 80 per cent. of acetylene will propagate combustion throughout the mass, but so slowly under all ordinary conditions as not to attain to the dignity of an explosion, and for all practical purposes the explosive limit may be taken as 3·5 per cent. of acetylene, the upper limit being of no importance, as so large a volume of the gas is never likely to be present in the air. An explosive mixture of acetylene and air theoretically attains its maximum power with a mixture of about twelve volumes of air to one of acetylene, but in practice gives greater explosive pressures with mixtures far richer in acetylene, for reasons which will be fully discussed in a later lecture. Ordinary coal gas forms explosive mixtures between the limits of 6 and 29 per cent., and yields its maximum result with a mixture of one volume of coal gas to about ten volumes of air.

The methods which could be and have been employed from time to time for the formation of acetylene in small quantities are excessively numerous, but, before the commercial production of calcic carbide made acetylene one of the most easily obtainable gases, the methods which were most largely adopted for its preparation in laboratories were: first, the decomposition of ethylene bromide by dropping it slowly into a boiling solution of alcoholic potash, and purifying the evolved gas from the volatile bromethylene by washing it through a second flask containing a boiling solution of alcoholic potash, or by passing it over moderately heated soda lime; and secondly, the more ordinarily adopted process of passing the products of incomplete combustion from a Bunsen burner, the flame of which had struck back, through an ammoniacal solution of cuprous chloride, when the red acetylide of copper was produced, and this on washing and decomposing with hydrochloric acid yielded a stream of acetylene gas.

This second method of its production, which was the one most usually adopted, has, however, the great drawback that unless proper precautions are taken to purify the gas obtained from the copper acetylide, it is always contaminated with certain chlorine derivatives of acetylene.

In the years 1890 and 1891 I devoted much time to trying to ascertain the various actions which take place in coal gas flames and which lead to their luminosity. The classical researches of Sir Humphry Davy first clearly showed that luminosity was due to particles of solid carbon heated to incandescence within the luminous zone, and my endeavor was to find the causes which led to the setting free of these solid particles. The gas which is supplied to us for illuminating purposes, whether it be coal gas, carbureted water gas, or oil gas, consists of a mixture of many gaseous bodies, of which hydrogen, carbon monoxide, and members of the methane and ethylene families form the largest proportion, while a small percentage is composed of gases such as carbon dioxide, oxygen and nitrogen, which are simply impurities.

When the homogeneous mixture of these varied constituents leaves the burner tip, and the gases find themselves in the presence of the atmosphere, they at once begin to diffuse into it with a rapidity inversely proportional to the square roots of their densities, with the result that the lightest and most abundant member of the gaseous mixture, hydrogen, finds its way quickly to the exterior, and methane soon follows. These two gases, constituting some 85 per cent. of the mixture, on meeting the air bear the brunt of the combustion, and in burning form the main portion of the sheath of complete combustion surrounding the lower part of the flame.

The heavier constituents of the coal gas are naturally those least affected by diffusion, and the desertion of the hydrogen and methane concentrates them in the center of the flame, and they flow upward, forming the non-luminous inner zone of the flame, or as it is more often termed, the zone of non-combustion. These gases are chiefly the unsaturated and heavier members of the saturated hydrocarbons present in the coal gas, and in their upward travel the baking action of the heat from the completed combustion going on in the outer envelope of the flame causes a resolution of the more complex hydrocarbon molecules into the simpler compounds, acetylene and methane. As these in turn diffuse outward, they reach the outer wall of combustion, which is undoubtedly the hottest part of the flame, and just below the inner side of the outer zone the acetylene heated to above its temperature of decomposition instantaneously splits up into finely divided carbon and hydrogen, and the heat liberated by the decomposition and by the change of state of the carbon, being localized by the rapidity of the action to the solid particles, so augments the temperature given to them by the flame that they glow with high incandescence, and form the luminous sheath which caps the inner zone of non-combustion.

Experiments made by withdrawing the gases from various parts of luminous flames showed that no matter what was the initial character of the hydrocarbon present, acetylene was always produced before luminosity made its appearance, and, moreover, that the illuminating power of the flame followed the ratio of acetylene so produced; and this fact, taken in conjunction with the observation that when acetylene, free from air, is allowed to flow through a Jena glass tube heated up to a temperature of 780° C., it is decomposed with luminosity, while the carbon set free in flowing forward through the zone of heat is perfectly non-luminous, formed the basis of what is now known as the acetylene theory of luminosity.

Stated in its simplest form this theory is as follows: In the same way that the decomposition of the acetylene in flowing through a heated tube endows the carbon particles with a luminosity which the heat of the tube alone is unable to impart, so does the decomposition of the acetylene generated in a hydrocarbon flame increase the light-yielding power of the carbon particles liberated by its decomposition over what might have been the light emitted had they only been heated to the temperature of the flame itself.

When it is considered what an enormous difference is produced by a few degrees of temperature in the light-emitting power of solids heated in a flame, it at once becomes manifest that it is at least injudicious for opponents of this theory to sneer at the effect likely to be produced by such increase in temperature as is given rise to by the decomposition of acetylene.

It is perfectly well known to everyone interested in the methods employed for burning coal gas that regeneration increases the light emitted by a flame over 100 per cent., and in some cases three times that amount, and yet the increase in the temperature of the flame due to warming the gas and air before combustion is but a small one.

I freely admit that when I first brought this theory forward in 1895, I placed too much dependence upon the measurements of flame temperatures by the methods at our disposal for such investigations, and in so doing laid the theory open to attack, an opportunity that was taken full advantage of; but in spite of all the criticism which has been bestowed upon it, the main issue has never been shaken, and I am just as fully convinced now as I was then that in all luminous hydrocarbon flames, acetylene may be truly looked upon as "the mother of the luminosity."

There are conditions under which acetylene can be burnt without the development of light. If acetylene be diluted with about 92 per cent. of hydrogen or carbon monoxide, the molecules are burnt up without decomposition, and there being no solid matter in the flame to heat to incandescence, the flame remains non-luminous. This is due to the acetylene requiring a higher temperature to decompose it when it is diluted than when it is pure, and the greater the dilution the higher the temperature needed.

If burning alcohol, which in the open air gives a faintly luminous flame, be placed under a bell jar, the temperature of the flame is lowered by some of the products of combustion being checked in their escape, and the flame becomes absolutely non-luminous; if now oxygen be supplied to the flame, its temperature becomes greatly increased, and not only does the flame become highly luminous, but freely deposits carbon on a cold surface held within it, while gas withdrawn from the interior of the flame under each condition is found to contain acetylene.

Another very striking example of the same kind is to be found in cyanogen, a gas which has always been noted for the beauty of the rose-pink flame with which it burns. Although cyanogen contains the same amount of carbon as acetylene, and is even more endothermic, no one until lately had ever thought of the possibility of its burning with a luminous flame, this being due to the fact that the temperature necessary to break up the molecule was so far above the heat of the flame that the cyanogen molecule burnt as a whole, and there being no deposition of carbon, no luminosity would result.

If, however, the cyanogen flame be surrounded with pure oxygen instead of air, a faint luminosity appears in the flame, owing to the increase of temperature; while, if the flame be surrounded by nitrogen dioxide, another endothermic compound, the temperature is so increased that the flame becomes more intense in its illuminating power than the acetylene flame itself, and yields a dense deposit of carbon and para-cyanogen to any cold surface held within it.

THE THUMB OR FINGER TIP PRINT AS A TEST OF IDENTITY.

ON the occasion of the first decennial of the introduction by the elder Galton into the system of measurements, etc., by which the French police assure themselves of the identity of criminals by the imprint of the tip of the thumb, or of a finger, it was stated in the French journals that these imprints had not once failed to make identification complete. The hair may change its color, the eyes may do likewise, the skin of the body may change from black to white, every feature of the face may be altered as age progresses, but the configuration of the lines on the palmar aspect of the finger tips never changes from youth to old age. While this fact has been utilized by the police of France for about ten years, only, and by those of other countries a shorter period, it has been known for a very long time.

In the exploration of some of the Central American ruins, the explorers, a good many years ago, came upon a room in one of the ruined palaces, on the walls of which, still plainly visible, were the imprints of innumerable finger tips, ranged in regular rows, showing that they were put there with some well understood intent, and it is suggested that it was for the purpose of identification, or that they answered as the seals and signs manual of those who placed them there. The British in India, and even some of our own explorers in New Mexico and Arizona, have made use of this plan to get the "signatures" of native chieftains and others to receipts for money paid and similar documents.

The general adoption of this method of identification in banking houses, express offices, the postal money order system, etc., would not only make errors in identification impossible, but furnish a ready means by which the proper party could always identify himself—not always an easy affair, as any one who has had dealings with such institutions can testify. The writer of this once spent three days in a large city, without money, although he had checks and exchange for a considerable sum. He was unknown, and could not furnish satisfactory identification. If, on purchasing the bill of exchange, he had furnished the bank with his "finger print," and that institution in advising its correspondent of the draft had sent the print along, he could, on presenting the check, have instantly given the strongest proof of identity by simply duplicating the forwarded print. A system of numbering and indexing the points would thus furnish banks an infallible and ready method of identification, which might be of the highest utility.—National Druggist.

SOME INTERESTING ELECTRIC MOTORS.

ELECTRIC motors are built in every variety and size by the Elektricitäts-Actiengesellschaft, late Schuckert & Company, Nüremberg. In recognizing the great convenience and other advantages which the use of electric motors offers, the United States took the lead and Germany followed. In the small town of Pforzheim, the municipal electricity works, built by the Elektricitäts-Actiengesellschaft, were, in 1896, supplying current to 415 electric motors, aggregating 128 horse power; the average power thus did not reach ⅓ horse power, and in fact there were 310 motors of $\frac{1}{10}$ horse power only.

The synchronous motors correspond to the respective generators, as they require fields excited by continuous currents and armatures fed with alternating currents. It is well known that synchronous motors have a constant speed which depends upon the frequency of the primary current and the number of poles; that they cannot start independently, are easily brought out of step by a slight excess in the load, and are then liable to stop. Various methods may be employed for starting such motors. It may be done with the help of a steam or gas engine, or of the accumulators and continuous generator which belong to the installation; or a small asynchronous motor may be resorted to. In the latter instance, the synchronous motor needs a friction clutch for disconnecting it from the machine to be driven, and the asynchronous motor a friction pulley; it is started idle, coupled with the load when purpose; otherwise, they can be dispensed with, for the current is supplied to the stationary field only, and not to any revolving parts. When such asynchronous motors have to start under load, the company apply the hydraulic clutch, shown in Fig. 1. A 7½ horse power monophase motor fitted with it is shown in Fig. 2. The fixed part of the clutch is the disk, 1, keyed to the motor shaft, 2, and provided with the concentric annular grooves, 3, 4, closed by the diaphragm, 5, and the rings, 6. The disk, 10, can be shifted endwise on the shaft, but cannot be rotated on it. The loose member of the clutch is the disk, 12, with the pulley; it rotates freely on the shaft, 2, but cannot be shifted endwise. When the motor is started the disks, 1 and 10, will turn with the shaft, 2; in the groove, 3, is liquid, which, with the increasing speed, flows through the port, 7, into the outer groove, 4, and bulges out the diaphragm, until the intermediate disk, 10, is pressed with sufficient force against 12 to effect the coupling. The time interval is adjusted by turning the screw which fits into the port, 7. The belt pulley can be replaced by other types of couplings.

In polyphase motors, in which two and more alternating currents act, the one after the other in different coils, a revolving magnetic field of more uniform strength is produced. These motors, hence, start under load and are not deranged by temporarily excessive loads. When external resistance is added, for which purpose rings and brushes are then needed as just explained, the speed can be adjusted. The Schuckert Company have done their share in solving these various problems. Before passing to applications of electric motors, and to auxiliary apparatus, we will mention that the transformers are built either in box shape or

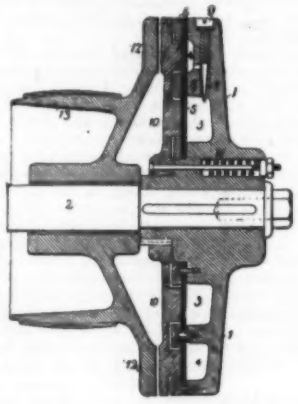


FIG. 1.—HYDRAULIC COUPLING.

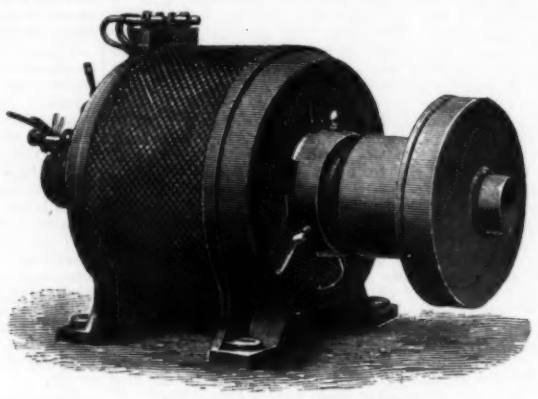


FIG. 2.—7½ HORSE POWER MONOPHASE MOTOR WITH HYDRAULIC COUPLING.

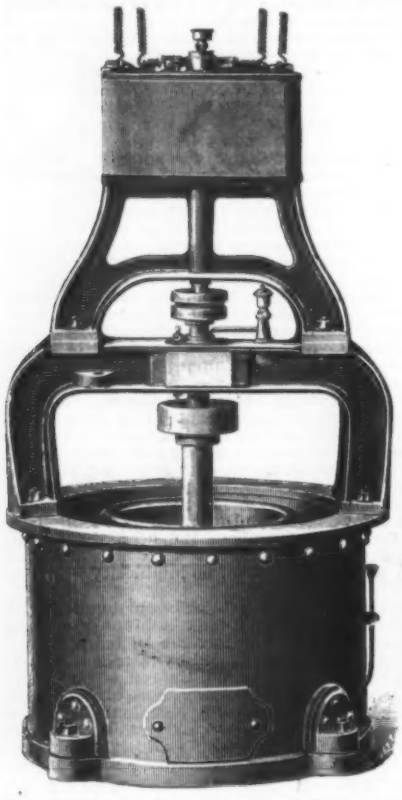


FIG. 3.—ELECTRICALLY DRIVEN CENTRIFUGAL EXTRACTOR.

FIG. 4.—CENTRIFUGAL EXTRACTOR WITH THREE-PHASE MOTOR.

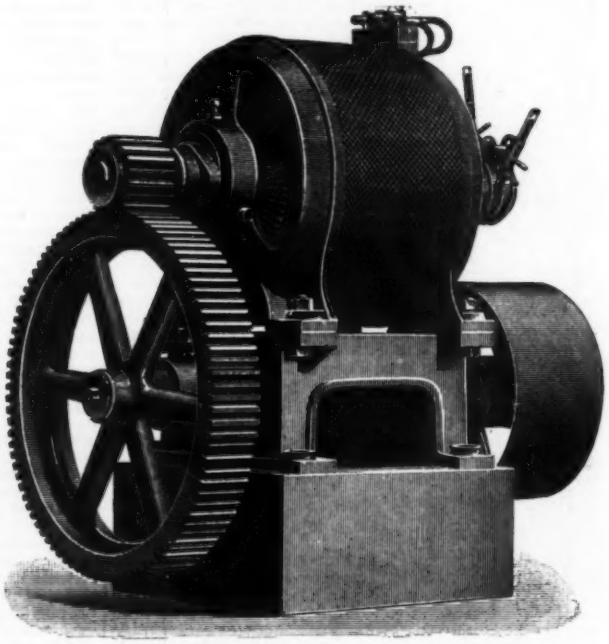


FIG. 6.—9 HORSE POWER THREE-PHASE MOTOR WITH GEARING.

FIG. 5.—2 HORSE POWER THREE-PHASE MOTOR WITH GEARING.

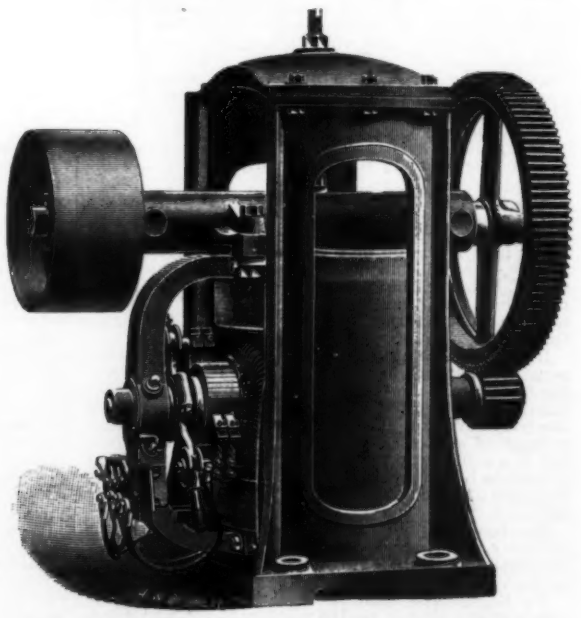


FIG. 7.—ELECTRIC MOTOR ADJUSTABLE IN ITS FRAME.

SOME INTERESTING ELECTRIC MOTORS

cylindrically, with three vertical iron cores between the common base and cover. The latter cylindrical shape is preferred, but not exclusively used, for triphase transformers.

Direct coupling of the motor to its load is possible in the case of high speed machinery, ventilators, centrifugal apparatus, etc. In the Vereinigte Bonifacius Colliery, at Kray, a Guibal fan has been replaced by a Schuckert ventilator. The power plant is about a mile from the new shaft, and comprises a 120 horse power engine driving by a belt a dynamo; two two-copper wires, ¼ inch in diameter, on iron poles, take the currents of 1,200 volts to the electric motor, which is fixed to the exhauster. In other instances, motor and exhauster rest on a common base. The ventilating installation of the new Diet building at Berlin, the work of David Grove, generally conceded to be a model installation, is fitted with twelve electric motors from Nüremberg. Four large motors of 85 horse power had previously been on trial with belt driving; flanges and leather couplings were afterward adopted. The speed can, by means of resistances, be reduced to one-half in ten stages. This half speed is taken as the normal; the ventilators are, therefore, coupled two in series for ordinary conditions and in parallel for full effect; the resistance further permits of toning the speed down to one-quarter.

In Fig. 3 we illustrate a centrifugal extractor installed at the sugar works of Langen Brothers, Köln. The continuous current motor is fixed above, can be shifted when the apparatus is to be cleaned, and can be run to act as a brake; it absorbs 8 horse power when making 850 revolutions. The triphase motor of Fig. 4 is placed underneath the drum, which can thus be taken out without touching the motor.

For driving at lower speeds, there are required either low speed motors, economical only when of large size, or belts or toothed gearings, or both combined. Such a combination with a 2 horse power triphase motor is illustrated in Fig. 5; the hollow shaft bearing rests on the motor frame, with the toothed wheel on the one and the pulley on the other side. In Fig. 6 the triphase 9 horse power motor is fixed to a cast iron base, which supports the second motion shaft; the usual gear ratio is 1 to 5. When almost vertical belts cannot be avoided, the E. A. G. uses the arrangement illustrated in Fig. 6, which permits of a vertical adjustment of the belt. Slide rails are fitted in the motor box, and the motor can be raised or lowered by means of the screw shaft which passes through the cover of the box.

For mines, the company have constructed electric locomotives, hauling engines, pumps, etc. At the Gute Hoffnungshütte continuous current motors of 50 horse power are employed; at Kladno, a three-throw pump with an electric motor is used, both being fixed on a truck. In the Schönberg collieries the electric pumps have proved a great success. Although the thermometer down below often descended to about zero Fahrenheit, a few resistance coils prevented all trouble from frost; this method of heating cannot be strictly economical, but it has given complete satisfaction. The electric locomotives are fitted with trolleys on steel arms (at Bockwa), and with contact bars or rolls on links (at Lythranda), all for aerial conductors; the tender of the accumulator locomotive at Kray carries a set of 40 Tudor cells. Among various other applications, we may mention an electric transfer table at the Cassel railway station; a peculiar traversing table at Dortmund, with a high skeleton tower supporting the contact bar; further, electric boring, turning, planing, and grinding machinery, motors for looms, wood working, paper making, printing, etc. Giesecke & Devrient, of Leipzig, have twenty-six electric motors of 3 horse power and less for actuating different presses, seven electric fans, 6 horse power motors for the lift, and eight motors in the stone grinding, bookbinding, and other departments. As the various machines do not run simultaneously, 90 kilowatts suffice for the whole concern and for illuminating the establishment.

In the lifts of the E. A. G. the electric motor and the worm are mounted on a common base, and the brake is in positive connection with the reversing gear; the motor is cut out when the lift is not in motion. The starting is effected by means of the hand rope; not directly, however, since that would lead to detrimental jerks, but through the intermediation of an auxiliary motor.

The device used for heavy lifts comprises a small auxiliary electric motor with a worm gear and a magnetic clutch whose armatures, by means of a toothed wheel, gear with a toothed rack gliding over a vertical row of contacts. These parts are put in circuit by the hand rope and a reversing switch lever turning about a horizontal pivot over arcs of contacts. The lift motor starts slowly; the contact slide cuts out resistance until the auxiliary motor and the magnetic clutch are short-circuited. The slide remains at its highest position until the reversing lever is put to rest again. A U-shaped rod connected by crank with the switch lever then pulls the slide back again. A 12 horse power lift of this kind, built by Messrs. Schelter & Gieseche, of Leipzig, is in use at the Schuckert Works in Nüremberg; it raises loads of 1·5 tons.

ELECTRICAL WORK DONE FOR SAMPSON'S FLEET BY THE "VULCAN."

When the United States repair ship "Vulcan" was fitted out at the Boston navy yard, early in June last, it was expected that the electrical installations on board modern men-of-war would be among the very first to make requisitions for repairs. The work was thoroughly anticipated. Every provision was made to meet possible exigencies of the situation off Santiago. Skilled electrical machinists were among her picked crew. Testing instruments and all kinds of electrical stores for marine installations were taken along.

Before the battle of Santiago, and after, electrical work and repairs were executed for the "New York:" two searchlights were replaced by new ones, the telephone system was tested for grounds and breaks, armatures of common fan motors were rewound and tested, and other motors were tested for grounds. The only other ship in the engagement for which the "Vulcan" afterward made electrical repairs was the "Indiana," whose small blower motors were overhauled and the armatures of two of them rewound.

Two vessels of the auxiliary fleet, the "Potomac" and the "Manning," called for minor electrical work and repairs to their signal and side lights, electric bells, rewiring of deck distribution and general overhauling of the electrical machinery.

The dynamo fields of the "Vesuvius" were very carefully tested and found to be without fault. When the "Maria Teresa" was brought to Guantanamo Bay for general overhauling by the "Vulcan's" force, previous to being taken north, the dynamos were thoroughly examined and found to be everywhere grounded. No attempt was made to repair them.—American Electrician.

FRENCH HIGH SPEED COMPOUND LOCOMOTIVES.

THE advent of the compound type of engine on the leading lines of the French railways dates back about twelve or thirteen years, and the trial that has been made of it during that period has permitted the fact to be recognized that the application of this principle is destined to give locomotives a power and an elasticity of operation that they have never hitherto possessed.

We have thought it would prove of interest to give a few details upon this subject in devoting ourselves especially to the engines used on the Railway of the North. We shall confine ourselves at present to the modifications that they have permitted of realizing in the running of trains.

The locomotives now in service upon the company's lines are sixty in number, and are distributed in four series, the successive designs of which have been studied with a view of obtaining a greater and greater effective increase in power and speed. Thus the last engines put in service present certain differences that are very marked as compared with the type that we have described on a former occasion. In Fig. 1 we give an external view of an engine of the most recent type, exhibiting the various modifications thus realized. This engine was built by the Alsatian Society of Mechanical Constructions under the supervision of M. du Bousquet, engineer in chief of the Railway of the North, in collaboration with M. de Glehn, the Alsatian Society's superintendent.

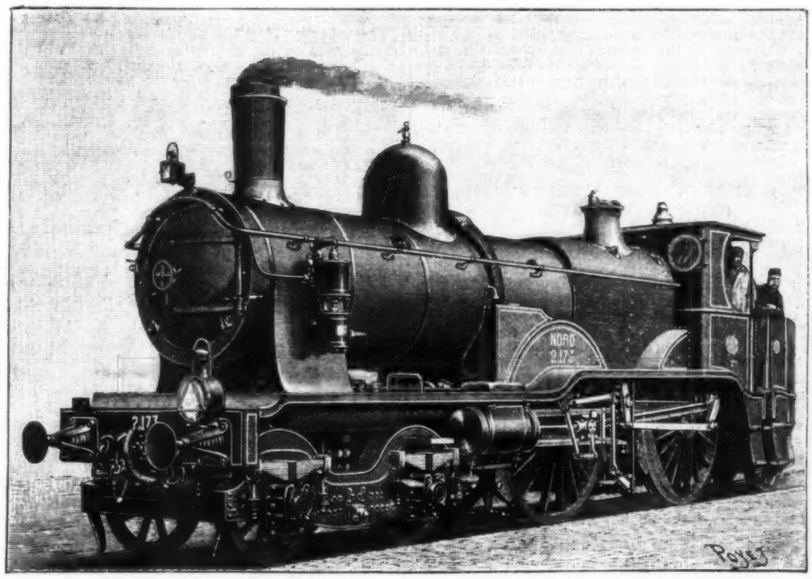


FIG. 1.—COMPOUND LOCOMOTIVE OF THE RAILWAY COMPANY OF THE NORTH.

In the type thus modified an endeavor has been made to facilitate the production of steam and improve the utilization of it, and to give the engine the minimum of weight of which it is susceptible.

In order to quicken the vaporization, the grate surface has been increased and the smoke tubes with smooth inner surface have been replaced by the Serve system of tubes with wings. The advantage of these tubes consists in the fact that in all tubular boilers the convection of the hot gases takes place with much more difficulty than the transmission from the external surface of such tubes to the water that surrounds them.

It is therefore important to facilitate the contact of the gases and the metallic walls by increasing the internal surface through the addition of wings. There is a further advantage, moreover, in doing this even at the cost of the inconveniences resulting from the diminution of the external surface and from the indirect increase in the thickness of the metal traversed by the heat. In fact, the water that surrounds the tubes always absorbs the heat under conditions that are much more satisfactory than those in which the heat of the gases is removed. The experience with locomotives of which the boilers are provided with Serve tubes furnishes a magnificent proof of the increase of vaporization that the use of wings permits of realizing. Let us observe, besides, that these wings constitute so many obstacles to retard the passage of the gases, and, from this point of view, further facilitate the absorption of the heat.

The arrangements that tend to improve the utilization of the steam in the engines under consideration consist in increasing the working register of the boiler to 15 kilogrammes, and in determining the dimensions of the high and low pressure cylinders and of the intermediate reservoir, and especially the degree of admission for the ordinary running, under the conditions that are recognized by experience as being the most advantageous. It is impossible for us to enter here into the details of these various arrangements, and we shall simply recall the fact that in the compound system the admissions are always more prolonged than the ordinary distributions, the expansion taking place in an appropriate cylinder; and it will be at once remarked that by this very fact all the inconveniences inherent to feeble admissions are avoided.

In order to increase the power of the engines, it has been necessary to increase the volume of the boiler and, at the same time, the area of the grate surface. The internal diameter of the cylindrical body has been increased to 1·35 meters, and this has necessitated the raising of the axis of the boiler by 0·2 meter above the rails. In order not to increase the total weight of the boiler too much, despite this increase in dimensions, the latter, as well as the fire box, has been constructed of steel plate.

The tender, the dimensions of which have been increased to such an extent as to raise the water capacity to 18 cubic meters, is supported by two jointed bogies.

As above stated, these high speed compound engines are now hauling the lightning express trains of the Railway of the North, and, despite the continual increase in weight that such trains are undergoing, have permitted of greatly increasing the speed that was anticipated.

If, for example, for the year 1892, we compare the speeds of the express trains hauled by the old style engines with those that are now built, we shall see that, upon the Paris-Lille line, such speeds, calculated between the terminal points, remained between 67 and 68·5 kilometers per hour, and, upon the Paris-Calais line, reached 67 and 73·3 kilometers. The mean speeds calculated between two consecutive stations were naturally slightly greater, and, with train 29, reached 72 kilometers in going from Paris to Longueau and 75 in returning by train 18. The speeds attained between Paris and Amiens rose to 76·1 kilometers with train 15 and train O of the Calais line, while train 16 has made

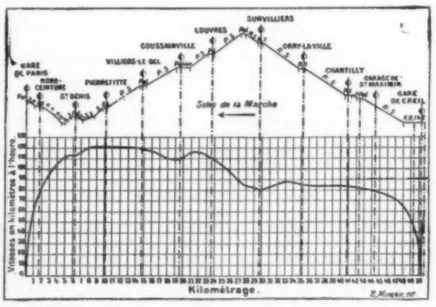


FIG. 2.—CURVE OF SPEEDS OF TRAIN No. 12, RUNNING BETWEEN PARIS AND CREIL.

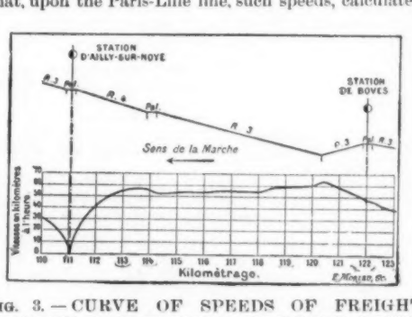


FIG. 3.—CURVE OF SPEEDS OF FREIGHT TRAIN L P, RUNNING BETWEEN BOVES AND AILLY-SUR-NOYE.

the maximum speed of 78·5 kilometers between Aulnoye and Busigny.

These figures are now greatly exceeded. The commercial speeds calculated between the terminal points reach, in most cases, 80 kilometers, and the mean speeds, calculated between two consecutive stations, generally vary from 82 to 85 kilometers. In the run from Paris to Amiens, for example, train R C going to Calais makes a speed of 92·2 kilometers. This train is now making the entire trip from Paris to Calais, say 296·5 kilometers, in 3 h. 25 m. only, while in 1892 the fastest trains took about 4 h. 10 m. So, too, upon the line from Paris to Lille (251 kilometers) the total duration of the trip is reduced from 3 h. 40 m. to 3 h. 8 m., which represents a saving of 32 minutes, say more than 14 per cent.

In a general way it may be said that gradients of 5 mm. are now ascended without the train showing any sensible diminution in speed, as may be seen from the diagrams in Figs. 2 and 3, selected from a large number of others, and No. 2 of which reproduces the curve of the speeds of passenger train No. 12 of March 27, 1897, between Paris and Creil, comprising 16 cars and weighing 186 tons, while No. 3 gives that of freight train L P of December 10, 1896, between Boves and Ailly-sur-Nove, consisting of 45 cars and weighing 683 tons.

We might multiply such examples, but shall merely mention the fact that those which precede suffice to show the importance of the progress made.

In 1892 a train composed of 26 axles, giving a load of 155 tons, was considered as heavy, and, with such a load, a speed of 65 kilometers was not exceeded in ascending gradients of 5 mm. It was, moreover, impossible to increase the load much and reach, say 32 axles, without incurring the risk of running behind time. At present trains frequently include from 36 to 40 axles, and loads of from 180 to 200 tons are reached and hauled at speeds of 80 and even of 85 kilometers up gradients of 5 mm.

These interesting results, moreover, have been obtained without any sensible increase in expense, since the consumption of coal by compound engines remains less than that of the old style ones in doing the same service. The increase in expense, which is connected only with the cost of lubrication, is very insignificant, since upon the total trip from Paris to Lille it reaches but 0·74 franc per train. On the other hand, the cost of repairs of the compound engines remains less up to the present than that of the old style.

For the above particulars and the accompanying illustrations we are indebted to La Nature.

THE TEST OF THE GATLING CAST STEEL 8-INCH GUN.

NEW YORK, January 12, 1899.

To the Editor of the SCIENTIFIC AMERICAN:

DEAR SIR: In view of the accident which destroyed the 8-inch cast steel gun at the Sandy Hook proving grounds on January 4, it may be of interest to your readers to examine the accompanying report by Dr. John N. Stockwell of an investigation of the effects of cooling on the strains of the different parts of the Gatling 8-inch caliber steel gun, cast in one piece, at the Otis Steel Works, Cleveland, O. It is evident that, by the cooling of the gun in the manner set forth, its inside would reach a condition of rigidity before the outside reached that condition, and a further cooling of the gun would create a system of strains upon the inner layers of the gun, the amount of which would depend upon the elastic limit of steel, together with the coefficient of the expansion of steel due to a given change of temperature, and the combined effects of these two causes would be beyond the reach of mere conjecture.

The problem of the amount and direction of the strains has been carefully determined by Dr. John N. Stockwell, of Cleveland, whose reputation as a mathematician and astronomer is international, and is a sufficient guarantee of the accuracy of his work. This he has accomplished with all desirable completeness for the case in hand. He has also considered with the same mathematical detail the effect of cooling wholly from the outside of the gun, and also the effects which would result from cooling from both the inside and outside at the same time. It should be borne in mind that the conditions of cooling in this type of gun can be varied and are under control, so that the amount of initial tension can be made as desired.

I have the honor to be,

Very truly,

Your obedient servant,

RICHARD J. GATLING.

Dr. R. J. GATLING:

DEAR SIR: I have the honor to submit the following report of an investigation of the effect of cooling on the strains of the different parts of the Gatling 8-inch caliber steel gun cast in one piece at the Otis Steel Works, Cleveland, O.

After a gun has been fabricated, the metal of which it is composed may be tempered in three different ways, namely:

First, by cooling wholly from the inside.

Second, by cooling wholly from the outside, and

Third, by cooling from both the inside and outside at the same time.

It is proposed to investigate the effect of each of these methods of cooling upon the permanent strains on the metal of the different parts of the gun.

The materials for the investigation are derived wholly from experiment, and may be classed as follows:

First, the expansion of steel by heat, which has been assumed to be $\frac{1}{87}$ for a change of temperature equal to the difference between the freezing and boiling points of water.

Second, the elastic limit of steel, which has been assumed to be $\frac{1}{1000}$; and

Third, the difference of temperature between the inside and outside of the gun when the cooling begins, which we have assumed to be 250° F.

No strains of greater intensity than the elastic limit of steel have been considered in this investigation.

We shall illustrate the effect of the different methods of cooling in the order stated.

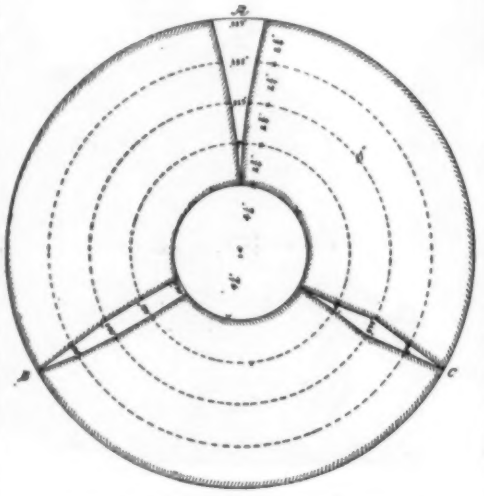
First, by cooling wholly from the inside of the gun.

The Gatling gun recently fabricated at the Otis Steel Works, in this city, has a bore of 9 inches in the powder chamber, the outside diameter being 81 inches. The strength of the gun is therefore equal to that of a hollow steel cylinder whose walls are 11 inches in thickness; and in order to illustrate the amount and intensity of the strains in the different parts of the metal arising from its cooling, we shall suppose it to be made up of 1,000 layers of steel ribbon 0·011 of an inch in thickness. It is evident that the strain on each layer of the steel ribbon would be equal to that arising from the shrinkage in length of each outer layer due to a loss of temperature of one-fourth of a degree Fahrenheit above that of its adjoining inner layer.

In building up a gun so as to illustrate the principle of cooling wholly from the inside, we shall suppose that we have a solid steel cylinder equal in size to the bore of the gun. Around this cylinder we should wind the first layer of steel ribbon without any strain whatever. The second layer should be stretched by about $\frac{1}{1000}$ of its elastic limit, if we suppose the gun to be made up of 1,000 layers. The aggregate amount of stretching of the first hundred layers would be about 0·28 of an inch; while the second hundred layers would be stretched 1·003 inches; the third hundred layers would be stretched 1·964 inches; and so on. The last hundred layers should be stretched 15·734 inches; while the last layer should be stretched 0·167 of an inch, or $\frac{1}{64}$ of its whole elastic strength. The whole amount of stretching would be 63·897 inches, or an average of $\frac{1}{4}$ of the whole elastic strength of all the metal of which the gun is composed.

Each layer should be stretched a little harder than the preceding one, until the last, which should be stretched about $\frac{1}{4}$ of an inch. If we had a steel ribbon 62,832 inches in length and 0·011 of an inch in thickness, it would make just 1,000 layers, which would make up the body of the gun without any strains whatever. If we shorten the ribbon by 64 inches, and then lengthen each layer by stretching it the same amount that it would shorten by cooling, we should have the body of the gun with the same relative strains in its different parts as would be produced by the process of cooling.

The inner layer of the gun is therefore strengthened by the sum of all the outside strains, since they all press toward the center of the gun; and they amount to $\frac{1}{2}$ of the elastic strength of the gun. The inner surface or layer of the gun is therefore strengthened by a cushion or buffer equal in strength to $\frac{1}{2}$ of the elastic strength of the gun. There is, however, an additional



CROSS-SECTION OF GATLING GUN.

Stresses calculated by J. N. Stockwell.

"A" shows amount of strengthening by cooling from inside.
"B" " " " weakening " " " outside.
"C" $\frac{1}{2}$ " " " strengthening " " " inside
" $\frac{1}{2}$ and " " weakening " " " outside at same time.

advantage in favor of a cast gun over a built-up gun in the absence of joints between the layers of metal.

Second, by cooling wholly from the outside of the gun.

In building up a gun so as to represent the strains of its different parts in the same manner and amount as they would exist if a cast gun were cooled wholly from the outside, we proceed as follows: We must stretch the first or inside layer of metal 0·0487 of an inch, which would be $\frac{1}{16}$ of its elastic strength. The second layer should be stretched a little less, so that it would not strengthen the first layer at all. And in general each layer should be stretched a little less than the preceding one, until the outside layer was reached, which should not be stretched at all.

The aggregate of all the strains would amount to 44·13 inches, which would be about $\frac{11}{16}$ of the whole elastic strength of the gun. But this force is negative, and tends to weaken the gun, so that in reality the gun would possess only $\frac{5}{16}$ as much strength as it would if it were cooled uniformly throughout the whole metal.

Third, by cooling from both the inside and outside of the gun at the same time.

To find the distribution of the strains due to cooling from both the inside and outside of the gun, we have only to consider the aggregate stretching of the first 500 layers of metal which make up the inner and outer halves of the gun. The aggregate stretching of the inner half of the gun is 11·012 inches, and adds 0·2637 to its elastic strength; while the aggregate stretching of the outer half amounts to 15·968, and weakens it by 0·3696. It therefore follows that cooling the gun from both the inside and outside at the same time makes a weaker gun than would result from a uniform cooling.

We have seen that cooling the gun from the inside adds $\frac{1}{2}$ to the elastic strength of the gun, and that cooling from the outside weakens it by $\frac{11}{16}$. It would seem to follow from this that the relative strength of the two guns would be as $\frac{1}{2}$ to $\frac{11}{16}$; or that the gun which was cooled from the inside would be about 2½ times stronger than the one cooled from the outside. But we must remember that each gun is only as strong as its inside layer of metal; and we have seen that the inside layer of metal in the gun which was cooled from the outside has already lost $\frac{11}{16}$ of its elastic strength by stretching, and that it derives no support from any of the outside layers of metal; while in the gun which was cooled from the inside, the inside layer has lost none of its elastic strength, and is also supported by $\frac{1}{2}$ of the elastic strength of all the metal outside of it. This would add tremendously to the strength of the gun; and a moderate estimate would show that the gun which was cooled from the inside would have many times greater elastic strength than the gun which was cooled from the outside.

The effect of the different methods of cooling is shown graphically by the drawing accompanying this report. If we suppose all the layers of metal composing the gun which was cooled wholly from the inside to be severed, the gun would spread apart as shown in fissure, *A*; and the pressure necessary to close up fissure, *A*, would be equal to the elastic strength gained by cooling from the inside. In like manner, if the metal composing the gun cooled wholly from the outside were severed, the gun would take the form indicated by fissure, *B*, and the pressure necessary to close fissure, *B*, would equal the force lost by cooling from the outside. And if the metal of the gun which was cooled from both inside and outside at the same time were severed, it would show a fissure of the form, *C*, the inner half of which strengthens the gun and the outer half of which weakens it.

All of which is respectfully submitted.

(Signed)

Cleveland, O. JOHN N. STOCKWELL.

CUT VERSUS WIRE NAILS.

To the Editor of the SCIENTIFIC AMERICAN:

Some time ago I noticed a couple of articles in your columns relative to the merits of cut and wire nails. As these articles make an unjust comparison between the two, I have been repeatedly prompted to write a correction. I concede that it may take a greater weight to start a cut nail from a single block of wood than it does to start a wire nail, because the cut nail has more frictional surface, but when the cut nail has been fairly started, it is practically drawn, while the wire nail continues to hold until the last. The cut nail, being wedge shaped, has the greater part of its friction removed so soon as it is fairly started. Not so with the wire nail, for, being the same size all the way, the friction remains the same on the portion remaining in the wood. To illustrate, suppose it takes 800 pounds to draw a three inch cut nail the first quarter of an inch, it will only take about 300 pounds to draw it the second quarter, and perhaps 75 pounds the third quarter, and 30 pounds the fourth quarter, and a few pounds for each remaining quarter; while a wire nail of similar size may be drawn the first quarter of an inch with 750 pounds, but it takes about 670 pounds to draw it the second quarter, and 600 pounds the third quarter, and 540 pounds the fourth quarter, and 490 pounds the fifth quarter, and so on to the end. Thus it will be seen that the holding qualities of the wire nail are much the greater.

From actual experience, I am of the candid opinion that the wire nail will hold more than the cut nail, especially after it has had time to corrode. Take the everyday experience of breaking up of old goods boxes. If put together with cut nails, they are easily knocked apart, and the lumber saved; while with wire nails it is not so easily done and the lumber is nearly always ruined. Fence pickets that have been nailed on with cut nails may be knocked off with one good blow of a hammer, while it takes several such blows to knock off a similar picket fastened with wire nails. I noticed the latter particularly in tearing down a picket fence in which both kinds of nails had been used indiscriminately. The wire nails, as a rule, refused to come out and either split the picket or draw through; while the pickets nailed on with cut nails almost invariably came off at a single blow. It will be observed that a large part of a cut nail, the thick end, is in the picket, while only the small end is in the timber to which the picket is nailed. As nails are generally used to hold two pieces of wood together, it will readily be observed that the original holding qualities are in favor of the wire nail.

Aside from the actual drawing of a nail, its toughness should be considered. The wire nail is much harder to break, and consequently has greater holding power.

The proper way to test the merits of the two kinds of nails is not to simply pull them out of a block at one pull, but to separate blocks nailed together, taking into account the power to separate them at one pull and also the aggregate power to separate them by fractions, that is, for each part of the separation. Different kinds of wood should also be used. I am confident that a fair test will show that the wire nail is much superior to the cut nail.

CHARLES H. BLISS.

Pensacola, January 2, 1899.

TESTING WIND FORCE.

EXPERIMENTS upon the exposure of anemometers at different elevations have recently been carried out by Mr. W. H. Dines and Captain Wilson Barker, on board her Majesty's ship "Worcester," of Greenhithe, says The Mechanical Engineer. Five pressure-tube anemometers were employed, the first being at the mizzen royal masthead, the second and third at the ends of the mizzen topsail yardarm, and the fourth and fifth on iron standards 15 feet above the bulwarks. The results show that the ship itself affected the indications of the lower anemometers, while some low hills and trees, which are a quarter of a mile away from the ship, to the south and southwest, also affected the wind velocity from those quarters. The general facts deducible from these observations are: (1) That anemometers must have a fairly clear exposure to be of much value for testing wind force; (2) that on a ship the results may be considered fairly accurately determined by having the instruments 50 feet above the hull, that on land it will generally be necessary to carry the instruments somewhat higher, to be determined entirely by the local condition; and (3) that no other form of anemometer offers such advantages as the pressure tube, from the fact that it can be run up and secured easily above a building.

ENGINEERING NOTES.

The United States appears to have acquired a valuable asset in Porto Rico, if one may measure value by the amount of waterfall energy in a country. General Roy Stone, of the United States volunteers, says the roads are ruined by the rainfall, and the only possible chance for traffic is the rail. The rivers have an average fall of 2,500 feet, and in their courses high waterfalls are numerous.

The Deutsche Kohlen Zeitung describes a lignite distilling plant, in the pipes of which the tar and water are condensed, the former being utilized for firing boilers in the following manner: On the boiler setting is mounted a cylindrical receptacle which, for effecting the separation between the tar and water, is heated by a worm traversed by the exhaust steam of the feed pump. The water is drawn off at the bottom, and the tar is collected in a receiver at a higher level than the boiler, descending by a pipe, through another coated with fireclay, to the furnace, where it burns with a short flame of dazzling whiteness without giving off smoke. A boiler fired in this manner is said to have double the evaporating power that it would have if fired by producer gas; and the products of combustion, which contain from 15 to 18 per cent. of carbonic acid, reach the chimney at a temperature of 220° C.

In boiler work for the United States navy, blue working without subsequent annealing is prohibited. This is interesting, as explanatory of this rule, that what is known as a critical temperature in the working of both iron and steel is at the so-called blue heat, this being from 450° to 600° F., and it is here that iron and steel are much more brittle when cold or at redness. On iron, however, this heat does not seem to leave any bad effect, though, if the piece be worked in such a range of temperature, it will retain the brittleness after cooling, and show a great loss of ductility as measured by the bending test, and the poorer the iron, the more susceptible it is to the blue heat. The danger to steel at this fatal blue is more pronounced than in iron, but it exists to a greater or less extent in all iron of whatever grade, is also more noticeable in a descending than in an ascending heat, and is especially marked in work having sharp corners, which has been worked at the blue heat.

Three Parsons steam turbines of 500 horse power each are about to be built by the Westinghouse Machine Company, East Pittsburg, Pa., for the Westinghouse Air Brake Company, Wilmerding, Pa., to replace the ordinary steam engines, says Engineering News. Each turbine will drive a 300 kilowatt generator, furnishing current for electric lighting and for driving the Tesla motors used in the Air Brake Company's shops. The Machine Company is also building a 2,500 horse power turbine for the United Electric Light and Power Company, of New York city, the first of an order of five of the same size. These will be the largest steam turbines ever constructed. They are to be installed in the new station at Twenty-eighth Street and East River. Each turbine will be used to drive a 1,500 kilowatt multiphase generator. The five engines and generators, aggregating 12,500 horse power, can be placed in about half the space now occupied by eight vertical Westinghouse engines of 1,200 horse power each, each with Westinghouse generators, now in the Twenty-eighth Street station. The Parsons turbine has been used in England for some time, giving excellent results as to economy. One of the advantages it offers is that the water of condensation may be safely returned to the boiler, as no oil is used in the engine.

A new application of the Poetsch process, for shaft-sinking by freezing, is proposed for a deep shaft at Harchies, Belgium, says Engineering News. The strata overlying the coal measures are 745 feet deep. The first 170 feet is made up of dry strata, of blue marl, etc., and the remaining 570 feet is sand heavily charged with water; the trial borings giving rise to an artesian well discharging nearly 23,000 gallons per hour, and rising 16 feet above the surface. The engineer proposes to form an ice wall by freezing from the outside; but as the freezing tubes might be crushed flat and circulation prevented by the enormous pressure developed in the lower strata, he proposes to keep the central boring open down to the coal. The top would be closed and provided with a stand pipe rising to a height equal to the hydrostatic head at the surface; then, any excess pressure due to increase of volume by freezing would be relieved by the surplus water flowing out at the surface. To prevent the freezing of the pipes in the upper dry strata, he would lead steam or hot water through a ¼-inch pipe placed in the central boring and going down to the bottom of the marl deposit. In this method the amount of water flowing from the relief pipe would be a good indicator of the progress of the freezing process.

Dispatches from leading shipbuilding centers on the ocean and on the great lakes testify to great activity in all lines of this industry. From Maine especially reports are good, as may be gathered from the following extract from a dispatch to The New York Sun: "The very best sign of the good times in Maine is the arrival of a shipbuilding boom which, while coming too late to make a great showing of tonnage launched this year, has set the yards and shops going at a busier rate than they have known for a decade. In years past Maine used to build from 40,000 to 70,000 tons of shipping annually, but of late, for reasons that have been told over and over again, the industry has fallen into decay, and the figures have been too small to be worth publishing. Now, however, Maine has a boom in her shipyards, and the good effects are felt from Portland to Eastport. Various causes have contributed to bring about this revival of shipbuilding, but the war with Spain and the commercial conditions and opportunities resultant therefrom are the chief factors. It cannot be said that the days of wooden ships have returned, for in all the lists of new vessels launched, in process of construction, or under contract there is not one wooden square rigger. Changed conditions demand new types of vessels, and Maine is now prepared to build anything wanted, from a palatial steam yacht to a coal barge. While the revival of business extends all along the coast, not much has yet been done at any place except Bath, which is the center of the shipbuilding industry in Maine."

ELECTRICAL NOTES.

A normal school in Wisconsin has been equipped with an electric programme clock system. Clocks are operated automatically from a central point, announcing the exact time for various studies and recitations, and indicating in which room they will be carried on. The superintendent has a telephone and switchboard that enables him to communicate with any teacher in the building without leaving his chair.

So far as electrical science is concerned, Japan is as modern as she has long been in technical instruction. In 1896 there were 20,000 kilometers of telegraph lines and 1,122 telegraph offices; the number of messages sent being 22,500,000. There were 870 kilometers of telephone line. In Tokyo are five central stations and 40,000 lamps; also two companies producing current for traction purposes; they produce about 30,000 horse power, and transmit to a distance of 55 to 60 kilometers.

A new process is announced for seasoning wood by electrical action, says The Builder. The timber to be treated is put into a quadrangular tank of liquid, immersed to rather more than half its depth, and an electric current applied through a metallic conductor, so arranged as to distribute it throughout the area, and it is stated that in a space of four minutes the sap begins to exude at the lower end of the wood; in six hours it is all extracted. The wood is then placed in another tank from which a septic solution is forced into the pores by an electro capillary method. If this process has successful results at a cost which will not be commercially prohibitory, it may prove of great importance; but we decline expressing any decided opinion on it until after the practical demonstration of it which is promised; we merely here call attention to the subject.

Now that the winter season is here again and more attention than ever is given to window displays, the use of electric heaters for preventing condensation on the glass windows is attracting attention. The scheme of operating an electric fan in the show windows to prevent sweating has already proved a practical success, but there are many cases in which a running fan is objectionable, not being in keeping with the display. As almost every store is now provided with electric light service and electric heaters can be purchased in all sizes on the open market, the interest in this new application of electric heating is universal. All that is necessary is to place a small electric heater in the window in any concealed position and to connect it with the lighting mains. The expense of operating would not be very great and the great nuisance of sweating windows would be entirely overcome.

The new electric searchlights which have been erected at various points to guard the channels leading to Portsmouth Harbor against night attacks by torpedo boats were, says The Daily Mail, tested recently by a series of experiments. These were witnessed by a large number of officers and proved eminently successful. Two well organized torpedo boat attacks were made on the defenses of the port, but the lights swept the approaches to the harbor, and on no occasion was an entrance effected unobserved. When discovered, the guns of the forts, loaded with blank charge, were brought to bear upon the destroyers which were told off for the purpose, and which made numerous but futile attempts to elude the lights. The object aimed at was to obtain some data as to the number of rounds each quick-firing gun could put into a vessel in a given space of time. The information thus gained is considered to be of much value, and other particulars furnished during the experiments should prove of the highest utility in the event of the forts being manned in earnest during a night attack.

Incandescent lamps are now very largely used for decorative purposes, particularly for electric signs in the theater district of New York city. In such a case as this, says The American Electrician, efficiency is not particularly to be sought after, for the object of the lamp is not so much to give light to surrounding objects as by its own luminosity to assist in tracing out the name or advertising sentiment so that it will appear brilliantly illuminated at a distance of many hundred yards. It is a fact that if letters of the sign are closely made and brilliantly lighted, the sign will be less legible than if the lamps were burned at a lower candle power, for the same reason that the true size and shape of an incandescent lamp filament can be best distinguished when burned at dull red heat. The eye is dazzled by more brilliant light. The outcome of this reasoning seems to be that a sign lamp must be burned at a considerably lower efficiency than one intended for ordinary illuminating purposes, partly because the signs will use less current and partly because the lamp will be of double or possibly triple life. The true commercial efficiency of the sign lamp cannot be measured in watts per candle power, for its object is to attract attention rather than to illuminate.

Over 4,000 telegrams were sent from the Weather Bureau Sunday morning, December 4, 1898, to different towns and cities along the North Atlantic coast notifying railroad companies, street railway companies, steamship managers, boards of public works and other city officials and postmasters, for the information of the public, of the approach of a terrible hurricane, which originated in Texas Friday night, December 2, and had been moving in a northeasterly direction at the rate of about 35 to 40 miles an hour, gaining in violence very rapidly until it had become one of the most extensive and devastating storms that had occurred for several years, covering an area of the entire country east of the Mississippi River. It was much more severe than the blizzard of the previous week, and the Weather Bureau was therefore very urgent in its warnings to shipping not to venture from safe shelter. William E. Curtis, the Washington correspondent of The Chicago Record, says that the warnings of the last gale were received by over 700 vessels on the North Atlantic coast alone, among others the "Portland," which refused to heed it, and went down with all on board. Between 8 and 9 o'clock Sunday morning the whole telegraph system of the United States, every wire of both the Western Union and Postal companies, was in use by the Weather Bureau for the purpose of notifying the public of this storm.

SELECTED FORMULÆ.

Metol and Pyro Developer.—

A. Pyro	45	grammes.
Metol	35	"
Potass. meta bisulphite	100	"
Potass. bromide	15	"
Water to make	16	ounces.
B. Sodium carbonate crystals	3½	"
Sodium sulphite crystals	½	"
Water to make	16	"

For use, mix equal parts A and B. The developer is very quick and gives splendid density, but must be thrown out after use, as it oxidizes very rapidly. For time exposures the pyro and soda is the best, thus:

A. Pyro	140	grammes.
Potass. meta bisulphite	15	"
Potass. bromide	17	"
Water to make	20	ounces.
B. Sodium sulphite crystals	2	"
Sodium carbonate crystals	2	"
Water to make	20	"

Use equal parts A and B.

Metol-Quinol Developer.—

Metol	10	grammes.
Quinol	90	"
Sodium sulphite	300	"
Sodium carbonate	600	"
Water to make	20	ounces.

Use equal parts developer and water.

Fixing Bath for Plates.—The Carbutts acid fixing bath is first class and does away with an alum bath, as it fixes and hardens at the same time. Probably most readers are familiar with it, but for the few that are not we will give it:

Fixing and Hardening Bath.—

Sodium hyposulphite	1 pound.
Sodium sulphite	2 ounces.
Chrome alum	1 "
Sulphuric acid	1 drachm.
Warm water	64 ounces.

Dissolve the hypo. in 48 ounces of water and the sulphite in 6 ounces. Mix the sulphuric acid with 2 ounces water, and add slowly to the sulphite solution. Then dissolve the chrome alum in 8 ounces water and add to the hypo. solution. This makes a clear, green solution, which can be used over and over again.

For films, a simple solution of hypo. is better with an alum bath in between. Speaking of films, to do good work with them you should provide yourself with the Ideal film holders, a set of pocket kodaks, 3½ by 3½ and 4 by 5 sizes. They are cheap and greatly simplify film developments.

Toning and Fixing Bath for All Gelatine Papers.—

1. Water	80	ounces.
Sod. hypo	1	pound.
Ammon. sulphocyanide	14	drachms.
Lead acetate	6	"
Citric acid	4	"
Powdered alum	4	"
2. Gold chloride	15	grammes.
Water	8	ounces.

Put up in 8-ounce panel bottles at 25 cents, using 1 ounce No. 2 (gold) and 7 ounces No. 1 to each bottle. It yields a very fine bath and will give excellent satisfaction.—American Druggist.

Tire Cement Containing no Carbon Bisulphide.—

A

1. Caoutchouc, fine shreds	1	ounce.
Chloroform	20	"

B

Caoutchouc, fine shreds	1	ounce.
Resin	3	drachms.
Venice turpentine	90	grains.
Oil turpentine	4	fl. ounces.

For the solution B, the rubber is shaved into small pieces and melted with the resin; the Venice turpentine is then added, and all is dissolved in the oil of turpentine. The two solutions, A and B, are then mixed.

2. India rubber	15	grains.
Chloroform	2	fl. ounces.
Mastic	½	ounce.

Mix the India rubber and chloroform together, and when dissolved the mastic is added in powder. It is then allowed to stand by for a week or two before using.

3. A recently patented "self-sealing" cement, according to an exchange, consists of glycerin holding gelatinous silica or aluminum hydrate in suspension. Three volumes of glycerin are mixed with one volume of liquid waterglass, and an acid stirred in. The resulting jelly is diluted with three additional volumes of glycerin, and from four to six ounces of this fluid is placed into each tire. In case of puncture the internal pressure of the air forces the fluid into the hole, which it closes.

Slating for Blackboards or School Slates.—The making of a good surface for drawing or writing on with chalk or crayons is not as easy a job as it would appear to be. The great secret of success, however, lies in avoiding grease or oil of any description in preparing the lacquer. The following give good results:

Shellac	250 parts.
Lampblack	25 "
Ultramarine	40 "
Rochelle salt in powder	125 "
Pumice stone	175 "
Alcohol	2,250 "

Dissolve the shellac in the alcohol and mix in the solid ingredients. Another good formula is as follows:

Shellac	500 parts.
Ivory black	250 "
Emery in fine powder	150 "
Ultramarine	125 "

Proceed as before. Wood naphtha may be used in place of alcohol as a solvent, if the rooms in which the boards are placed are left open long enough for the odor to evaporate before the classes assemble.—Färben Zeitung.

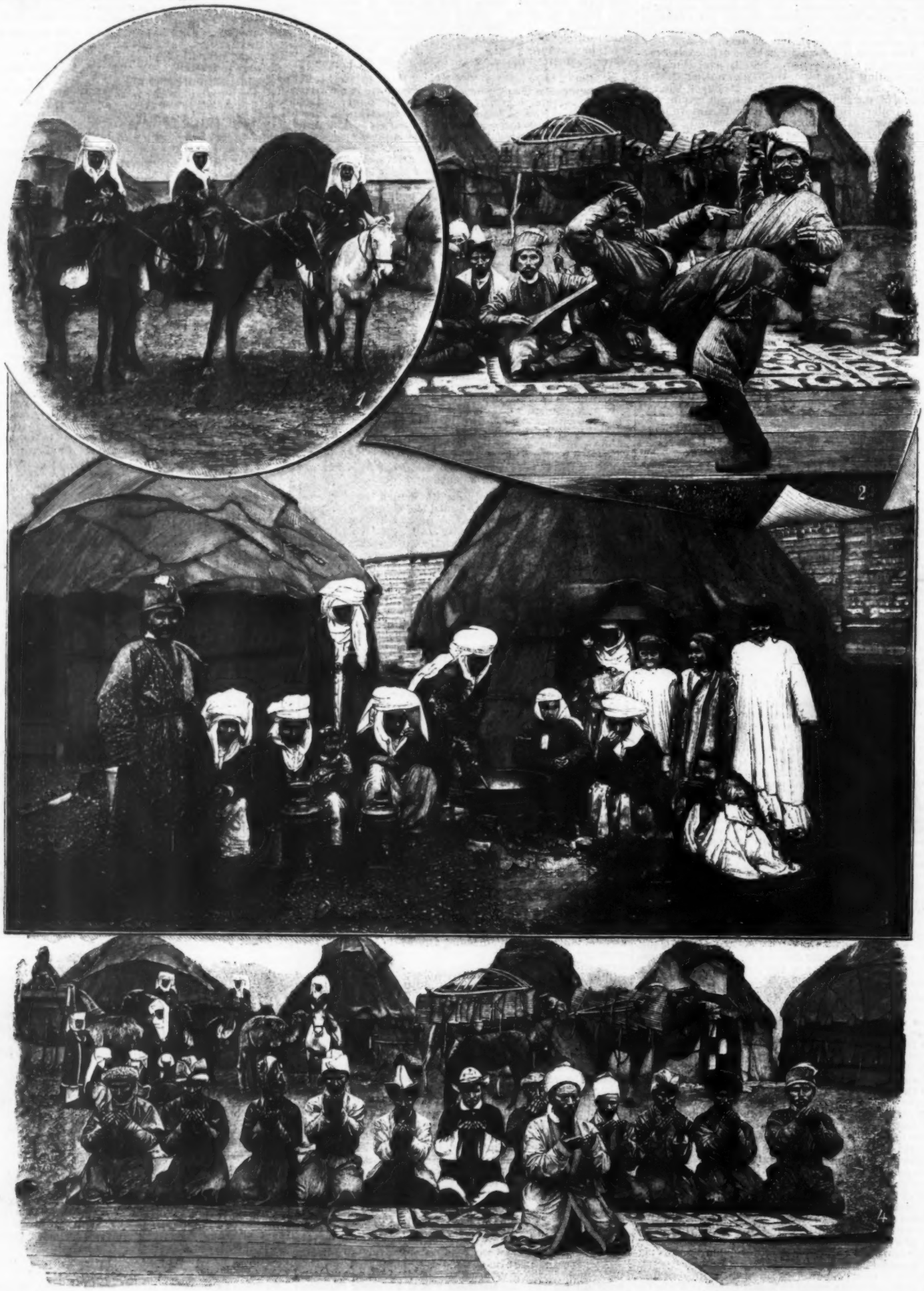
KHIRGIZIAN AND TARTAR CARAVANS IN GERMANY.

THE Khirgizian and Tartar caravans which have been traveling from one German city to another are natives of the region about the banks of the Volga and the shores of the Caspian Sea. The greater part of the company is composed of Khirgizians, with whom are associated several Tartars and two German-Russians from the Moravian community in Sarepta. The troop is under the leadership of a Chan, lives in tents, and carries along horses, camels, wolf dogs, and falcons.

The public performances of the company begin with a prayer, in which the men with bared feet kneel upon rugs and repeat the invocations and chants of their leader. The women kneel behind the men. After the prayer has been ended, the men put on their shoes and roll up the rugs. The steppe ponies are then quickly saddled and mounted. Shouting, the riders gallop wildly about, and, even at full speed, skillfully pick up various objects from the ground. The women then jump upon the horses and show the same dexterity. Then, to the sound of the sambysa, a guitar-like instrument, a dance is begun. After a wrestling match, the tents are struck, and the nomads seek another pasturage. Here the tents are again erected and a meal prepared.—Ueber Land und Meer.

AMERICAN SALESMEN IN EUROPE.

I HAVE recently had a conversation about Russian trade with two very intelligent salesmen—one an Englishman and the other an American. The American salesman has lately returned from Russia, where he traveled over 5,000 miles in the interest of his house; while the Englishman returned to Birmingham after



1. Khirgizian women on horseback. 2. The national dance. 3. The mid-day meal. 4. A prayer.

THE KHIRGIZIAN AND TARTAR CARAVANS AT THE MUNICH OCTOBER FESTIVALS.

a Russian business tour of 7,000 miles for his British firm.

They both believe, when trading in Russia, in handling your own money receipts and in having your own inspection of rejected goods. It is too easy for a commission agent so very far away to claim "bad packing" and "defective parts" in bicycle and machinery shipments, and these expert salesmen are amazed that one American bicycle manufacturer has allowed his Russian commission agent to recklessly overstock every Russian dealer he could persuade to take bicycles, with "leave to return unsold goods." With so many "openings," this agent is, of course, receiving a good deal of cash and has remitted enough to America to make a showing with his principal. But there is a crash foreboding. Both salesmen have declined to allow that agent to handle their goods.

The English salesman, who, I understand, is a reliable person, states that an American manufacturer has the run on scales and is finding that his trade marks and reputation for making the best scales give him very handsome returns for his goods in Russia, and sales are made so readily that perhaps he is not giving as careful attention to his interests as he should. At any rate, the English salesman asserts that the sole Russian agent of the American scale manufacturer is having imitations of the American scale made, placing the name and trade mark of the American manufacturer on them, and pushing them when he can, thus defrauding his principal and customers. The American, receiving generous orders for the genuine scales, does not suspect his agent of the trick.

I have written letters to the two American manufacturers giving them this information in detail.

Both salesmen have been in Russia before, and are enthusiastic over the possibilities of sale for any line of manufactured goods, if proper methods are adopted to introduce and handle them. They add that Germany has such a hold commercially that antagonism to German merchants is developing, and there is in consequence an opportunity for Americans and Englishmen.

During the past six months I have met fully sixty American salesmen, many of whom have made continental business tours, and I have heard a number confess that they made mistakes in agency arrangements on their first trip, by getting into the hands of people who speak English. They found an English-speaking "green goods man" planted in nearly every continental hotel. Of course, they do not get caught a second time, and the great growth of American trade in Europe is largely due to the ability and energy of the high class commercial travelers sent abroad, including graduates from many colleges and mechanical and technical schools. There is now a very important body of men trained and experienced in European trade, and it might be well for them to organize, so that manufacturers could write and get the names, addresses, and references of anyone available for employment. It sometimes happens that an effort in some line of trade proves unprofitable, and the men are recalled when the experience they have had has fitted them for other lines. The knowledge of a country and its business methods is often more valuable than the knowledge of a particular business. Men who have this knowledge should not be permitted to return to their old occupations in the United States, where they are soon lost to sight.

The bicycle business is settling down into regular and profitable channels, and in certain directions experimental work is being given up; consequently, some bicycle men with valuable experience are being ordered home and others may be recalled. It has cost the bicycle trade a good deal of money to train these men, and it is to be hoped that the manufacturers of other lines now entering into foreign competition will profit by it, by seeking out and engaging not only those bicycle salesmen who have been successful, but also those who have not met with the same good fortune, for they will know how to do better next time. If, according to business ethics, it be deemed fair to do so, there will be no great harm done to the existing bicycle trade and to the big trade in automatic machinery if other American manufacturers now seeking European trade employ a few of the trained salesmen of those houses. The bicycle and machinery firms have their trade so well established that they will know how to replace men taken. For an American manufacturer opening up a foreign business, there is no more important consideration than the employment of a competent representative.

A profitable business can be carried on here only by personal solicitation. One may find reliable commercial agencies, but they are so very reliable that they are afraid to tell you anything you want to know. There is no Dun's, no Bradstreet's, to depend upon. A competent representative must not only know the people and the country in which he is to work, and the standards of measure, weight, and value, but he must be an accurate judge of credits and know all the side tricks.

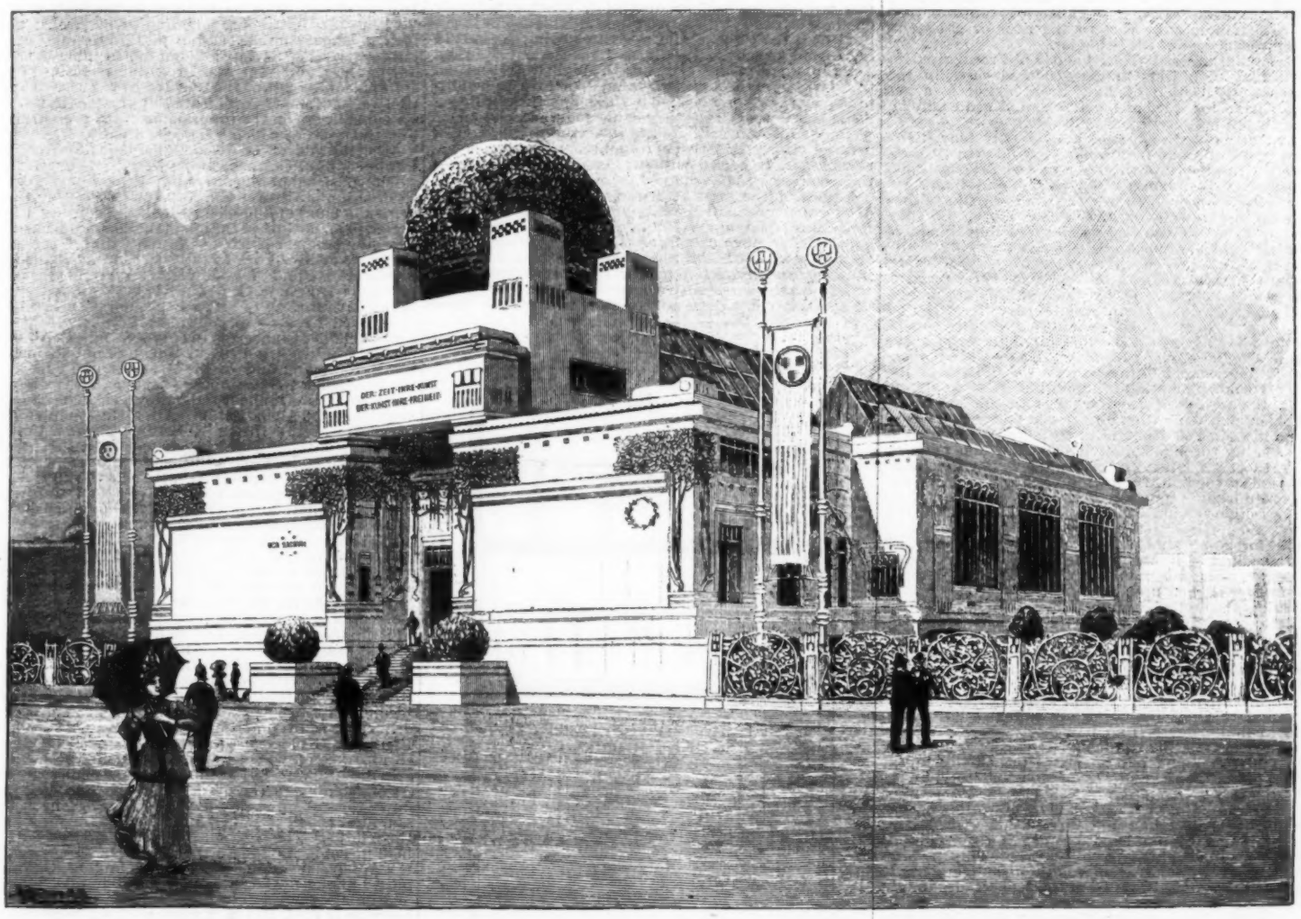
One mistake which our manufacturers make so frequently that it has become a very grave matter is the custom of giving exclusive agencies with reckless haste, and with practically no investigation of what advantages might result from other methods of sale. Assured of the financial responsibility by some successful firm of foreign merchants offering cash up to 75 or 80 per cent. on consignment, or even full payments, they will sign a contract for an exclusive agency, without any effort to find out whether there is an ulterior motive behind the proposition. A $5,000 order now and then —just enough to make a show of progress and to keep the manufacturer content—is a very cheap way of keeping a superior article out of the market. In one order many "nice American styles can be obtained." The copying of American styles is as well understood here as the American copying of Paris styles. A clever foreigner may want an exclusive agency for the sole purpose of learning these styles and suppressing competition. In one case I have in mind, where a buyer was referred to the European agency of an American house, the sale which was finally transacted through this very agency was of a foreign adaptation of the American article and not the article itself. The "special agent" will sometimes serve his principal in this fashion, instead of allowing him to adapt his goods to the foreign demand by keeping him informed of the particular needs of the market.

MARSHAL HALSTEAD.
United States Consul, Birmingham.

NEW BUILDING OF THE UNION OF AUSTRIAN ARTISTS.

THE new building of the "Vereinigung bildender Künstler Oesterreichs" (Union of Austrian Artists) in Vienna has a most exotic appearance in the streets of the Austrian capital. It is even more remarkable and peculiar in appearance than the accompanying illustration would lead one to suppose. It was opened November 10, 1898, with an exhibition of Secessionist productions which was interesting for many reasons. The building, which was the work of the young architect Olbrich, was completed in six months, and then, as the city presented the ground, it passed immediately into the possession of the society. Even while in course of erection, the structure was the object of the most varied criticism, arousing admiration or horror according to the school to which the critic belonged; and probably this will continue until these opposite points approach and meet in a spirit of unprejudiced toleration. But when will that be? But on one point the adherents and the opponents of the modern school agree; that is, in praise of the decoration and arrangement of the interior, which are remarkably well adapted for the exhibition of paintings, and in this respect might well serve as a model.

The exterior of this blindingly white structure is in Assyrio-Egyptian style. The broad front is almost bare of decoration, and is broken only by the square entrance niche, which is approached by a flight of steps. The flat roof is crowned by a square structure with four corner pillars, between which rises a gilded dome. This dome is formed of the round crown of a wrought iron laurel tree, composed of 3,000 leaves each over a foot long, and 700 berries as large as a man's fist, and these are airily arranged over an invisible frame. From this arbor-like dome, which, as we have already stated, is gilded on the outside and is painted green on the inside, a most beautiful view of the city can be obtained. Over the entrance, in gilt letters, is the inscription, "Der Zeit ihre Kunst, der Kunst ihre Freiheit," the motto of the constantly increasing Secessionist movement. At the left of the entrance we read Ver Sacrum. This is the title of the well edited and richly illustrated organ of the Vienna Secessionists. At the right, in an elegant case of glass and brass, is a fine mosaic statue of Pallas Athene by Strasser. The door is of wood stained green and decorated with beaten copper in the form of a gigantic flower, the stamens of which form a glided lattice. The square vestibule leading to the halls and the halls themselves are arranged and decorated, in every detail, in the Secessionist style. For this reason they are well worth seeing, and constitute the most perfect setting for productions of modern art. The engraving and article have been published in the Illustrirte Zeitung, to which we are indebted.



THE NEW EXHIBITION BUILDING OF THE UNION OF AUSTRIAN ARTISTS, IN VIENNA.

WOODEN BOXES FOR COAL IN ENGLAND.

UNDER date of November 28, 1898, Consul Halstead, of Birmingham, writes:

"The metal coal scuttle found in American homes, painted, japanned, enameled, in many styles and shapes, is not used in England. In its stead, there is

used an ornamental hard wood box, made of any one of the different kinds of wood, furnished with a solid stationary brass carrying handle, and a drop lid which conceals a galvanized iron coal box, which slips in and out of the box easily. It is really an attractive piece of furniture for a room, and to my mind is better than the metal coal scuttle. While this box may be used in some parts of the United States, at this moment I am not able to recollect a single house which has one. I believe our hard wood manufacturers, because of convenient supplies, could not only develop an export trade with these boxes, but would find a ready sale for them in the United States."

ARCHÆOLOGICAL MUSEUMS.*

MODES OF LIGHTING—EFFECT OF GLASS UPON LIGHT.

By Dr. THOMAS WILSON, United States National Museum, Washington, D. C.

GLASS plays an important role, as a material, in museum building and installation. Besides its ordinary use for windows, it enters largely into the construction of cases. The combination of different materials in the construction of cases is for the twofold purpose of protection of the specimens and to secure their best display.

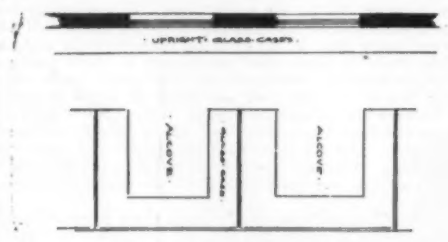
Glass may affect the transmission of light by reflection, by refraction, or by absorption. All bright surfaces reflect light. The surfaces of oil paintings and the glass which protects water colors reflect light in a greater or less degree, and this is so well recognized that it is universally avoided by museum authorities. A skylight is imperative for a gallery of paintings, that the reflection may be cast to the floor or elsewhere than into the eyes of the beholder.

The similar necessity is frequently not recognized in the display of objects in glass-covered cases in the museum. Reflection of light from glass cases has usually been regarded as inevitable, and ordinarily no steps, or but few, are taken to avoid it.

Light can enter a museum hall in only four directions, or but through four kinds of windows: (1) horizontally through low windows in the side walls, (2) perpendicularly through a skylight, (3 and 4) at varying angles between these two, the windows being either high up in the walls or in the clear story. Complementary to or in contrast with these four kinds of entering light are four kinds of cases receiving light: (1) upright, wherein the glass doors are perpendicular, (2) flat-top cases with horizontal glass, and (3 and 4) where the glass top or door is tilted at different angles, one being slightly off the horizontal and the other off the perpendicular. These four kinds of cases can be arranged so as to reflect the entering light into the eye of the beholder or away from it. A case with perpendicular glass, like No. 1, receiving the light from the low perpendicular window opposite, like No. 1, will reflect the horizontal entering rays into the eye of the beholder almost as though it was a mirror; the horizontal glass in case No. 2 will reflect the perpendicular rays coming through the skylight in the same manner, while the two slope-top cases 3 and 4 will correspondingly reflect the light from windows 3 and 4. All these are graphically represented by the drawing, which shows sections of halls with various windows and glass cases. So much for reflection of light in a museum.

The foregoing study of reflection led me to investigate the loss of light by means of glass, whether by reflection, refraction, or absorption. My first inquiry was as to what had been done in this regard by former investigators, and what reports had been made on the subject. An extended search in scientific works on light, accompanied by inquiries of persons most likely to know, failed to develop anything on the subject. Mr. Francis Galton published a little brochure entitled "Healthy Dwellings," a paragraph of four lines of which was lately reproduced in the SCIENTIFIC AMERICAN, and this has been the only notice I have been able to find. There is an immense mass of scientific investigation relating to the loss of light by both reflection and refraction, but it relates principally to the lenses of telescopes, and was of no avail to me. My investigations, therefore, proceeded on nearly original lines. I soon found the subject more difficult of accomplishment than I had anticipated. I regard it as almost impossible (at least for me) to get absolutely correct results. This is owing to the many possible changes in the premises and conditions. The glass to be tested may not always be of the same transparency. That made in different countries, and not infrequently that made in the same establishment and of the same kind, will differ perceptibly in transparency. They may be of different shades of color. Changes are produced in the physical structure of glass by long exposure to the chemical action of sunlight. (See "Character of Sunlight on Glass," by Thomas Grayfield, A. A. A. S., Boston meeting, 1880, vol. xxiii., p. 333; also Silliman's Journal for 1867.) A change in conditions may arise from different lights; sunshine or cloudy days, morning, afternoon, and evening, may produce different results. All tests have to be determined at last by the eye, and its unreliability in this regard is well known. According to Fechner's law, the sensation of light upon the eye is never numerically proportional to the stimulus, but only to the natural logarithm of the stimulus. The stimulus of a light of 16-candle power, instead of producing a sensation on the optic nerve or the brain sixteen times as great as a single candle, will be only 2·77 times as great, and 100-candle power only 4·6 times as great as a single candle. (These smaller figures are the logarithms of the larger.) This is a fine illustration of the adaptation of nature; for if the sensation should equal the stimulus, the optic nerve which could accommodate itself to the light of a single candle would be paralyzed by the light of an electric lamp of 2,000 candle power, or by a glance at the sun.

Various schemes were essayed and various machines tried, and I have at last been compelled to content myself with the results furnished by general averages. I made, first, a sort of camera obscura, with two chambers of equal size, the outer end closed, but with two equal apertures in the center; the inner end was left open, but, when in operation, to be covered with ground glass. When the machine was pointed toward the sky, the light therefrom passing through the two apertures was shown upon the ground glass. If the light through one of these apertures was reduced by the introduction of a piece of glass, it was made manifest by a corresponding reduction of illumination on the ground glass at the other end, and, as the two chambers were in juxtaposition, the difference in illumination could be easily seen. Unequal illumination was (under Fechner's law) difficult of correct determination; therefore, the open aperture was reduced in size until the illumination from the two aper-

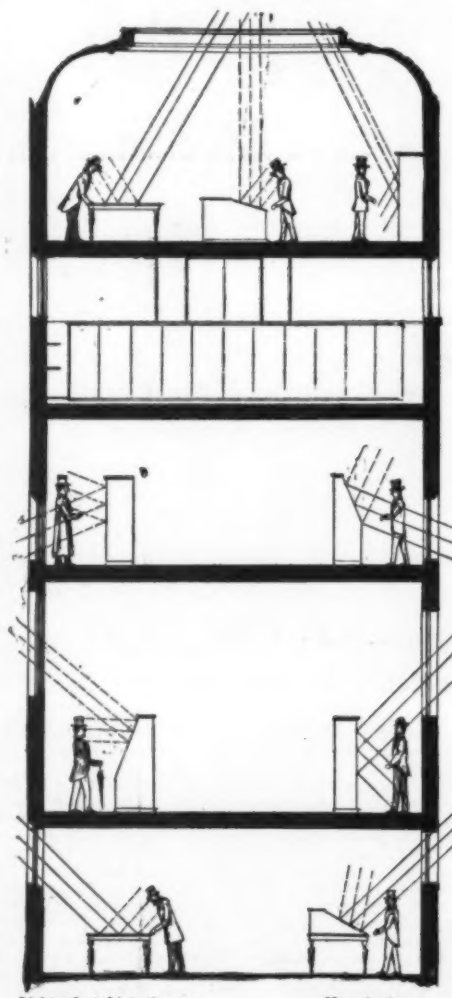


LIGHTING AN ALCOVE.

tures, as shown on the ground glass, should be equal. Then the obstruction of light of the tested glass was calculated by a comparison with the required reduction of the aperture. That is to say, if the aperture was reduced one-half or one-third, it admitted only one-half or one-third as much light. This machine was used in a dark room, the apertures being exposed to light from the sky.

A Bunsen photometer was used. Light was admitted to a dark room through two equal apertures some distance apart. The rays from these apertures were reflected by mirrors until they came together, end on, at which point was exhibited to them the diaphragm of greased paper. This was tested by exhibitions of various kinds, with and without glass, until its substantial accuracy was determined.

A piece of the glass to be tested was placed over one of the apertures and the diaphragm moved back and forth until the lights from the two apertures were equal. The distances from the two apertures were respectively noted, and the squares of these distances indicated the respective proportion of the light admitted from their respective apertures. In order to increase the correctness of results, the glasses were



Light reflected into the eyes. No reflection.

PROPER METHOD OF LIGHTING MUSEUMS.

changed from one aperture to the other, and the tests were made from both sides.

Table showing obstruction of light by different kinds of glass as determined by (1) a camera obscura and (2) a Bunsen's photometer:

	Light obstructed.	
	Camera.	Photometer.
1 French plate, ¼-inch, clear	8·34 to 12·50	12·00
1 American cryst. dbl. th., ⅛-inch, clear.		
1 American cryst., sgl. th., ⅛-inch, clear		
1 hammered, ⅛-inch	12·50 to 16·67	15·70
1 ribbed, ¼-inch	25·00	22·50
1 French plate, ground one side	41·67	45·20
1 American, double thick, ground one side.	50·00	54·00
1 French plate, ground two sides	58·33	61·50
1 American, doub. thick, ground two sides.	62·35	65·00

* Read before the Mid-winter Meeting of the American Association for the Advancement of Science, December, 1898, held at Columbia College, New York city.

ELEVENTH WINTER MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA.

By E. O. HOVEY.

ALTHOUGH the first meeting of the Geological Society of America took place eleven years ago, in Ithaca, it was merely one of organization, so that the meeting which was held at Columbia University, from the 28th to the 30th of December, 1898, really rounded out the first decade of active life and work of the Society and marked an epoch in its history. The report of the council showed that the Society had had a very prosperous year, and it reviewed in brief measure the history of the decade. In the words of the introduction to the report, the Society has united the geologists of the continent, produced harmony of feeling, thought, and labor, created and cemented friendships, and prevented the geology of America from becoming provincial. It has stimulated research and publication, and has placed on record a great body of knowledge. The avowed purpose of the Society, "The promotion of the science of geology in North America," has been carried out, and already the Bulletin has given it a prominent place among the older geological societies of the world. The Society began with 112 "original" fellows, and now numbers 237 in active membership. Five years ago the Society had secured the adhesion of nearly all the active geologists of the continent, and since that time the membership has remained practically uniform, the losses being balanced by the elections. The geographical distribution of the present fellowship is very wide, thirty-five States and Territories being represented besides the District of Columbia, Canada, Mexico, and Brazil. Thirty-seven members live in the District of Columbia, twenty-nine in the State of New York, twenty in Canada, fifteen in Pennsylvania, nineteen in Massachusetts, eleven in Illinois, and ten in California. The Society lost but one member by death during 1898, and that was Prof. James Hall, the veteran paleontologist of the State of New York. The activity of the fellows is indicated by the fact that forty-six papers were on the programme of the present meeting, thirty-six of which were actually delivered.

After the address of welcome, delivered by President Low, of Columbia, the necrology of the year was read, which consisted of a memorial of Prof. James Hall by Prof. John J. Stevenson, of New York University. With the hand of a life-long friend the speaker briefly sketched an outline of the life of the celebrated scientist to whose labors, carried on for more than sixty years, the State of New York owes more than its citizens appreciate. He told of young Hall's early boyhood and youth at Hingham, Mass., with very limited educational advantages; of his early love for natural science, as evinced by his walking from Hingham to Boston and back, a distance of twenty-five miles, to attend each of the lectures delivered at the Lowell Institute by B. Silliman; and of his struggles and success at the Rensselaer Polytechnic Institute at Troy, where he came under the influence and instruction of that pioneer geologist Amos Eaton. After the completion of his course at the Institute, Eaton got him a position as librarian there which barely gave him subsistence, but it enabled him to continue his studies and work in geology. Hall's connection with the working out of the geology and paleontology of New York thus begun continued almost uninterruptedly, though sometimes at his own expense for field and office work, to the day of his sudden death, August 7, 1898. During the intervals of his official connection with the work in New York he acted as State geologist of Iowa and afterward of Wisconsin and carried on extensive investigations in the Northwest and West at his own expense or in connection with government expeditions. The amount of valuable geological and paleontological literature which has appeared over his signature is something marvelous, and is ample testimony to the activity of his mind. He was recognized as one of the greatest scientists in his line that the world has ever known. After reading his memorial of Prof. Hall, Prof. Stevenson delivered the presidential address, "An Outline of the History of Geological Societies in America," an extended abstract of which may be found in the SCIENTIFIC AMERICAN SUPPLEMENT for December 31, 1898. After listening to these addresses, the Society settled down to two and a half days of solid work in hearing and discussing the papers prepared for the meeting by the fellows. The next meeting of the Society will be held in connection with the American Association for the Advancement of Science, at Columbus, O., in August, but the next winter meeting is to take place at Washington, D.C. The president elected for the ensuing year is Prof. Ben K. Emerson, of Amherst College; the vice-presidents are G. M. Dawson and C. D. Walcott.

Out of the great number of papers read, it will be possible to give only a selection of those which seem to have the most general interest, and to give but a brief outline of each of these. The first paper read was by W. O. Crosby, of the Massachusetts Institute of Technology, and was entitled, "The Archean-Potsdam Contact in the Vicinity of Manitou, Colorado." By means of photographs and diagrams the author showed the remarkably plane character of the contact of the Archean granite and the Potsdam sandstone, which is in striking contrast with the existing topography of the granite even in coastal regions. The paper distinguished and described in detail with numerous illustrations the original and secondary irregularities of the contact, the latter including a few flexures and numerous small faults which throw important light upon the origin of the sandstone dikes of the Manitou district. The original irregularities of the contact are all small, and, as a rule, evidently related to the occurrence in the Archean granite of a coarse concentric or spheroidal structure. The general conclusion of the paper was that the Archean land surface must have passed with extreme slowness beneath the waves of the Potsdam Sea.

"Outline of the Geology of Hudson Bay and Strait," by Robert Bell, of the Canadian Geological Survey. The author considers Hudson's Bay to be an inland sea rather than a bay. It is about 1,000 miles long by about 600 miles in extreme width, but its greatest depth is only about 70 fathoms, while the depth of Hudson's Strait reaches 300 fathoms. The text books of geology represent the Archean nucleus of the continent as embracing Hudson's Bay within the arms of its V-shaped area, but the actual structure of the region

is not as simple as the books would seem to indicate. While Laurentian rocks border the bay on the east and part of the west sides and Huronian beds form the shore at the northwest, the southern shore of the bay and the western shore of St. James' Bay are occupied by strata ranging in age from Cambrian to Devonian. Considerable gold seems to exist in the iron pyrites of the northwestern portion of the region, and has also been reported from the Huronian rocks quartz veins of the same region. Middle Silurian rocks occur on the east, west, and north sides of the bay and in Baffin Land. The Devonian area southwest of James' Bay is very large, and rocks of the same age are known to occur on Southampton Island. No good coal has been found anywhere in the region, though poor material occurs. Iron ore is abundant. Even in Devonian times the seas were independent of the Ontarian Devonian and supported a distinct form. The whole surface of the rock is glaciated, and in such a way as to indicate the probability that the ice came from Labrador. Remains of the mammoth (*Elephas Columbi*) have been found on Long Island at the entrance to St. James' Bay, and those of the mastodon near York Factory on the main bay.

Henry B. Kümmel, of Chicago, Ill., in a paper entitled "The Newark System in New York and New Jersey," stated that the rocks form a northwestward dipping monocline, interrupted by gentle folds and many faults, two of which have a throw of several thousand feet. The character of the rocks varies greatly, so that subdivisions established in one area do not hold for the entire field, and yet subdivisions based on lithological characteristics are the only ones possible. Both extrusive and intrusive trap sheets occur, and their relations to the sedimentary beds are instructive. The question of thickness is complicated by the faulting, and estimates vary from 12,000 to 15,000 feet. The strata were probably accumulated under estuarine conditions in shallow water. The surrounding land areas seem to have been reduced nearly to base level and deeply covered with residuary materials immediately preceding the deposition of each bed, but during their deposition subsidence of the estuary and elevations of the surrounding areas were in progress.

N. H. Darton, of the United States Geological Survey, in three papers gave the results of studies made in the Black Hills during the past season, the most important of which was the discovery of fossil fish remains in the Jurassic strata of the region. The author also announced the occurrence of marine Jurassic in the southern Black Hills and of a horizon of large vertebrates in the lower Cretaceous. Extensive and beautiful shore lines and deposits of Tertiary lakes occur far up on the slopes of the hills and throw interesting light on certain stages of the physiographic development of the region and the origin and condition of deposition of some of the White River sediments. A fourth paper by the same author dealt with the relations of the Tertiary formations in the western Nebraska region.

I. C. Russell, of Michigan University, then rapidly sketched the general geology of the Cascade Mountains, in northern Washington, as obtained from a reconnaissance made last summer. W. J. McGee and W. H. Holmes, of the Bureau of Ethnology and the National Museum, followed with a description of the geology and archeology of the California gold belt, in the course of which the former showed that the famous human skull from beneath the lava stream in Calaveras County was a fraud, though the latter did not consider the question settled. In the discussion which followed, W. H. Brewer, of Yale University, defended the authenticity of the discovery, he having been a member of the geological survey of California at the time of the alleged finding of the skull, and having handled the object soon after it was taken from the ground and while the dirt was still sticking to it.

C. D. Walcott, Director of the United States Geological Survey, made the important and rather startling announcement that last season he had discovered distinct fossils 4,000 feet below the base of the Cambrian beds, in Montana. The remains consist of fragments of crustaceans, closely related to *Eurypterus* of Upper Silurian age. These are the earliest definite organic remains now known. Specimens were shown.

"The Origin of the Grahamite in Ritchie County, West Virginia," was the title of a paper by I. C. White, State Geologist of West Virginia. Grahamite is a black, coaly mineral, looking like anthracite. It is very closely allied to the albertite of Nova Scotia. In Ritchie County it occurs in a vertical fissure, nearly five feet in greatest width, seven miles from the ridge known as the Oil-break, which is the top of an anticlinal fold. Years ago it was mined for use as a fuel, but never at a profit. Within about a year well-paying oil wells have been put down within a few hundred feet of the fissure. The theory of origin is that the fissure, which was produced by the forces causing the anticline, tapped the Pottsville conglomerate oil sand, and that the oil flowed until nature plugged up the orifice with the oxidized oil, paraffine, tarry products, etc., from the consolidation of which the grahamite has resulted. Grahamite consists essentially of 79 per cent. carbon, 6½ per cent. hydrogen, and 14 per cent. oxygen. In West Virginia it and its related oxygenated hydrocarbons are considered economic guides to petroleum, if the country is not too much broken up by folds.

Another paper of economic interest was that by Edward Orton, State Geologist of Ohio, on the structure of the Iola gas field in Allen Co., Kan., read by J. C. White. Natural gas is more widely distributed, geologically and geographically, and exists in larger quantity than any one would have claimed twenty or even ten years ago, its productive horizons covering the entire Paleozoic column of the country. Two distinct divisions can now be made of its accumulations, viz.: That which is stored in impervious rocks, such as shales and most limestones, and that which is found in porous rocks. These subdivisions may be provisionally styled shale gas and reservoir gas, each having characteristics of its own. Shale gas occurs in comparatively small wells, which lack uniformity of rock pressure. It does not occupy definite horizons; it exists independently of petroleum in many cases, and it has staying qualities, not depending on the structural arrangement of the strata which contain it. Reservoir gas is found in great wells, one in West Virginia having produced 75,000,000 cubic feet a day. It approaches uniformity of rock pressure in each subdivision of territory; it occupies definite horizons; it is accompanied by oil, and its wells generally come to a sudden end. Furthermore, it has accumulated in sandstones and conglomerates. Two structural phases of rocks are especially important in this connection, the anticline and the terrace, and the time has come for the acknowledgment of structure in reservoir gas fields even in advance of measurements. The gas field of Iola, in the southeastern corner of Kansas, is one of great promise. Its source is in a sandstone of the Cherokee shales, near the bottom of the Coal Measures, and its area is about seven miles long by three miles in extreme width. This horizon proves to be a terrace of well marked character. The top of the rock has an average elevation of 131 feet above tide, at no point rising more than 45 feet above this. At this summit the largest well of the field is located, and produces 10,000,000 cubic feet per day. The gas is being used in enormous quantities, and to very great present commercial advantage by the smelters of the Joplin district in the reduction of lead and zinc ores.

"The Conshohocken Plastic Clays," by T. C. Hopkins, State College, Pa. These deposits, which are of high economic value, lie about thirteen miles northwest of Philadelphia. Though their origin is doubtful, their close resemblances to the New Jersey and Gay Head, Martha's Vineyard, clays in colors, texture and structural features suggest that they, likewise, are of Cretaceous age.

George M. Dawson, Director of the Geological Survey of Canada, then described the remarkable land slip which took place on the Rivière Blanche, Portneuf County, Quebec, last May. A clayey area, about 2,000 feet long by 1,700 feet in maximum width, became supersaturated with water after the heavy snowfall of last winter, although the rainfall of the spring was somewhat less than usual. This whole mass, to a depth varying from 15 to 30 feet, suddenly flowed out through an orifice between 200 and 300 feet in width, which it made in the river bank, and filled the bed of the river for two miles below where it entered. The river bed at this point averages 1,000 feet in width, and the fluidity of the invading mass is further shown by the fact that the slope of the bed here is about 15 feet to the mile. The area excavated by the slide lay about 17 feet above the river, covered about 86 acres, and its volume is estimated at 93,000,000 cubic feet. One peculiar feature of the event was the great blocks of unsoftened clay which were carried out by the avalanche. The beds are known as the Leda clays.

"Ripple Marks and Cross-bedding" was the title of a paper by G. K. Gilbert, of the United States Geological Survey, in which were given the results of studies made principally during the past season on the Medina sandstone strata in the vicinity of Lockport, N. Y. The author found that there was great variation in the direction of dip of the cross-bedding of the strata, and he finally came to the conclusion that these were to be regarded as giant "ripple marks." Ordinary ripple marks, up to four inches from crest to crest, are widely distributed, and are known to be due to the action of waves on the sea bottom. The height of the causative wave is estimated to be twice as great as the distance from crest to crest of the ripple mark, though this proposition has not yet been fully established. Since some of these Medina ripple marks are 30 feet across, this would necessitate waves of 60 feet in altitude for the Medina seas, though the greatest ocean waves of the present seas are less than 50 feet in height. One of the lantern slides shown in illustration of the paper was from a photograph of a complete wave mark 23 feet between crests and 29 inches in depth, taken in a quarry near Lockport, N. Y.

A second paper by Mr. Gilbert described some features of ice sculpture in western New York State. Careful study of the Niagara escarpment, in Niagara County, shows that its greater features are preglacial, but that glacial erosion wrought important modifications. The Medina shale was so deeply sculptured as to obliterate its preglacial relief and substitute a broad fluting in the direction of the ice movement. At Thirty Mile Point a mass of strata, several hundred feet broad, was moved by the ice.

H. F. Reid, of Johns Hopkins University, described, with the aid of lantern slides, three of the great extinct volcanoes of southeastern Russia. Elbruz is the highest mountain in Europe, and its whole upper portion is composed of volcanic materials. It has a double summit, each peak of which is an ancient crater. Kasbek, also, is considerably higher than Mont Blanc, and its summit shows a crater. The glaciers on its sides add a feature of interest. Ararat, on the boundary between Russia, Turkey, and Persia, has two summits, seven miles apart, and with 4,000 feet difference in elevation. There are two domes at the summit of Great Ararat, but any evidences of crater are hidden by the great amount of perpetual snow. The outline of an ancient summit crater is indicated on Little Ararat by three resisting masses of solid lava. The summit of Little Ararat shows much "fulgurite," or rock which has been changed to glass by the fusing action of strokes of lightning.

The local geology of Manhattan Island was treated of in a paper by F. J. H. Merrill, of Albany. The stratified rocks within this area belong to two principal geologic subdivisions, the Precambrian and the Paleozoic. Of the Precambrian, only one member has been recognized, which has been called the "Fordham Gneiss." Of the Paleozoic, there are two persistent members, the "Inwood Limestone" and the "Manhattan Schist," and there is a third, of local and slight development, the "Lowerre Quartzite," which underlies the limestone. The Fordham gneiss, named from the former town of that name, is a gray, banded gneiss. It forms the east shore of the Hudson in southern Westchester County and the ridge on the east side of the Harlem River, above One Hundred and Fifty-fifth Street. On Manhattan Island it is exposed between Seventh and Eighth Avenues, south of One Hundred and Fifty-fifth Street. It also forms Blackwell's Island and the west shore of Long Island. The Inwood limestone is the crystalline limestone of southern Westchester County and Manhattan Island, and is an abundant source of good building material. The Manhattan schist is the prevailing rock of Manhattan Island, and forms the north shore of Long Island Sound. The important waterways about New York city owe their origin chiefly to the solution of the crystalline limestone and the subsequent submergence of the region, and the western part, at least, of Long Island Sound owes its origin to the same causes.

There were several papers of interest and value to petrographers, but they were, of course, technical in character. B. K. Emerson, of Amherst College, described the granite areas of central Massachusetts and the pebble-bearing schists accompanying them. The schists have been dissolved by the granites in many places. J. F. Kemp, of Columbia University, noted the occurrence of dikes of metamorphosed basic igneous rock in the Manhattan schists near One Hundred and Eighteenth Street and Morningside Park, New York city. A second paper by the same author gave the results of some studies which he has been making on the granites of the north shore of Long Island Sound. He concludes that the granites are of igneous origin, that they are intrusive in character, and that they have suffered much from the pressure due to the movements of the earth's crust. Comparison of chemical analyses of granites from all along the Atlantic coast from Maine to Virginia shows that the kind known as biotite granite predominates. H. P. Cushing, of Adelbert College, announced the discovery of an intrusive igneous rock near Loon Lake, N. Y., which has caught up fragments of the Grenville series of the Laurentian. The rock is related to the augite-syenites and is very much like other igneous rocks in Franklin County. L. V. Pirsson, of Yale University, discussed the phenocrysts of intrusive igneous rocks. "Phenocrysts" are the porphyritic crystals which are found in many lavas and other igneous rocks, and have long been held to have been formed within the interior of the earth before the rock reached the position in which it now is found. Prof. Pirsson contends that many of these crystals, as far as the intrusive rocks are concerned, did not form until the rock reached the place in which it solidified, and that there has been but one period of crystallization, though very complex conditions prevailed during it.

Pleistocene geology was by no means neglected, though there were not as many papers read on the subject of glacial deposits as there have been at some other meetings of the society. A. P. Coleman, of Toronto, delivered a paper on the Iroquois beach, in which he announced the discovery of the first fresh water fossils found without doubt in these deposits. As the main Pleistocene beaches from glacial Lake Agassiz to Iroquois contain fresh water shells, they must have been formed in lakes and not in arms of the sea. The numerous marine shell-bearing deposits of the eastern part of Canada cease before Lake Ontario is reached.

W. D. Johnson, of the United States Geological Survey, in a paper entitled "An Unrecognized Process in Glacial Erosion," advanced the proposition that, in addition to the recognized process of scour, the action of which is downward and forward with the glacial advance, there is a hitherto unrecognized process of sapping, the action of which is horizontal and backward. The tendency with glacial scour is to produce sweeping curves and eventually a graded slope, while that with the sapping process is to produce benches and cliffs. The author considers the latter process to be altogether dominant over the former.

C. W. Hayes, of the Nicaragua Canal Commission, described "The Geology and Physiography of the Lake Region in Central America." This region lies in southern Nicaragua and northern Costa Rica and includes the route of the proposed canal, and the lakes in it are the largest in the western hemisphere south of the Great Lakes. The region is characterized by two forms of topography, viz., the recent volcanic mountains and plateaus in which the original constructional forms are more or less perfectly preserved and the areas of Tertiary igneous and sedimentary rocks in which the forms are due to long continued subaërial erosion. A noteworthy feature is the absence of any continuous mountain range or chain of dominant peaks in this portion of the isthmus. A shallow depression occupies the western portion of the region, its longer axis being nearly parallel with the Pacific coast. This contains the Lakes Nicaragua and Managua. The former is 110 miles in length, with an area of 3,000 square miles and a mean altitude of 106 feet. Its greatest depth is 200 feet. No rocks older than the Tertiary are found along the line of the canal. The conditions throughout this region, but particularly in the eastern portion, are favorable for rock decay and the regolith is unusually extensive. In the eastern section it consists of red clay at the surface, with a depth of 10 to 30 feet, then blue clay with a somewhat greater depth, passing down into thoroughly weathered rock or saprolite in which the original structure is more or less perfectly preserved. The depth to hard rock varies from 50 to 150 feet. In the western section the regolith is much thinner and the red clay is almost entirely lacking, the residual products being blue or gray. In early Tertiary time this portion of the isthmus may have been wholly submerged. In middle Tertiary time there was an uplift and long continued erosion, the previous volcanic topography being obliterated and the region, at least toward the south, being reduced to one of low relief. In late Tertiary or Post-Tertiary time the isthmus was elevated at least 300 feet and deeply dissected. Following the elevation came a renewal of volcanic activity. A series of vents opened on the Pacific side and their ejectamenta built a dam across the previously existing Nicaraguan gulf, thereby forming the lake basin. As this dam increased in height the waters behind it rose until they overtopped the continental divide and escaped to the Atlantic, forming the present San Juan River. The region has suffered a more recent depression, by which the rivers were drowned. The estuaries thus formed have since been silted up.

Other papers on the programme were by N. S. Shaler, of Harvard University, on the conditions of formation of dikes and vein fissures, on the loess deposits of Montana, and on the spacing of rivers with reference to the hypothesis of base leveling; by J. B. Tyrrell, of the Canadian Geological Survey, on gold mining in the Klondike district, and on glacial phenomena in the Yukon territory; by H. W. Turner, of the United States Geological Survey, on the geology of the Yosemite National Park; by T. G. White, of Columbia University, on the faunas of the upper Ordovician

strata in the Lake Champlain Valley; by C. W. Hall and F. W. Sardeson, of the University of Minnesota, on the wind deposits of Eastern Minnesota; by F. P. Gulliver, of Southboro, Mass., on the terraces of the Thames River in Connecticut; by W. O. Crosby, of the Massachusetts Institute of Technology, on the Nashua Valley glacial lake; and by J. A. Holmes, State Geologist of North Carolina, on the geology of the mica deposits of the United States.

UTILIZATION OF UNIO SHELLS FOR BUTTONS.*

THE valuable possibilities of using Unio shells in making buttons have at last attracted attention, and an important industry is developing. A correspondent of the St. Paul (Minn.) Dispatch, under date of November 13, 1897, gives an extended account of the shell-button manufacture at Muscatine, Ia., where already a number of factories are in operation. No dates are specified; but the statement is made that it was begun within a few years past by Mr. Boepple, a German, who recognized the possibilities of such an industry and established a factory at Muscatine, soon employing 200 operatives, besides a number of outside people gathering shells from the Mississippi River at that point. The enterprise proved profitable, even under an unfavorable tariff, and several other factories were established; but since the recent protective legislation has gone into effect the business is increasing largely. Eleven or twelve factories are now in operation, running 300 saws and employing 1,500 people. One of these was working on double time, to fill orders for 20,000 gross of buttons for the "holiday trade" of 1897. The business is already an important element in the prosperity of the town; and as the supply of shells is enormous, it is expected to increase in extent. Other works exist in Iowa, at Davenport and Sabula, and at Cedar Rapids, on the Cedar River. There are also Eastern factories referred to, that cut the shells into "blanks"—i. e., unfinished disks—and send them to Muscatine to be polished and perforated.

The shells have been heretofore gathered by men and boys wading in the shallow water, and working from boats in the deeper parts with rakes provided with a wire net or basket. Now, however, one boat has been built for steam dredging, and another is under construction. The dredge will take up a ton of shells in an hour, and the steam will be used to cook the animals and clean the shells—a process now slowly conducted in small furnaces. As the gathering cannot be carried on in winter, when the river is frozen, prices rise in the autumn. Several species are capable of being used, of which two are particularly mentioned; these are "nigger-head" shells, which have risen with the approach of winter from 35 cents per 100 to 70 cents, and "sand" shells, which have advanced correspondingly from $1 to $2 per 100.

If the myriads of shells destroyed by the pearl hunters could only be gathered and sent to the factories, or if cutting works could be established in the districts affected by the "pearling" fever, much of this fine material could be utilized. On the other hand, the development of a large demand for shells by this industry and the introduction of steam dredges to gather them by the ton from water too deep for the pearl hunters to deal with, threaten within a few years' time to obliterate the Unio fauna largely, if not wholly, from our waters.

Following are some statistics in regard to the pearl button business:

Selling price list: First quality: 16 line, 48 cents per gross; 18 line, 51 cents per gross; 20 line, 55 cents per gross; 22 line, 60 cents per gross; 24 line, 65 cents per gross; 26 line, 70 cents per gross.

Second quality: 16 line, 40 cents per gross; 18 line, 43 cents per gross; 20 line, 47 cents per gross; 22 line, 52 cents per gross; 24 line, 57 cents per gross; 26 line, 62 cents per gross.

Third quality: 16 line, 27 cents per gross; 18 line, 30 cents per gross; 20 line, 36 cents per gross; 22 line, 37 cents per gross; 24 line, 41 cents per gross; 26 line, 45 cents per gross.

Prices paid sawyers: 26 line, 10 cents per gross, sawing whole shell; 26 line, 11 cents per gross, sawing butts; 24 line, 8½ cents per gross, sawing whole shell; 24 line, 9½ cents per gross, sawing butts; 22 line, 7½ cents per gross, sawing whole shell; 20 line, 7 cents per gross, sawing whole shell; 18 line, 6 cents per gross, sawing whole shell; 16 line, 5½ cents per gross, sawing whole shell.

By whole shell reference is made to sawing all the 26 line blanks there are in the shell. A gross is 14 dozen. The extra 2 dozen are to make up for the imperfect blanks or buttons, and these are all counted by weight. By butts are meant two different lines of blanks cut from one shell.

Prices paid grinders: 1 cent facing on grinder; 1¼ cents grinding one side, per gross, all sizes.

Prices paid turners: 24 and 26 line, 4 cents per gross; 20 and 22 line, 3½ cents; 16 and 18 line, 3 cents; scratch center, 2 cents per gross; ring center, 1¼ cents.

Prices paid drillers: 3½ cents per gross 4-hole, all sizes; 2 cents per gross 2-hole, all sizes.

Carding: 5 cents per gross.

The capacity of a 10-saw factory is from 800 to 1,000 gross per week. The Muscatine buttons now bring a better price than the Eastern goods.

Several button companies are now fully organized, and are producing large amounts of material.

In view of the button industry, even more than of the occasional yield of pearls, the question begins to arise as to the artificial culture of Unios. Between "pearling" and dredging for button factories, the supply, however abundant, must soon be greatly reduced, if not exhausted altogether, unless some means can be found for increasing and maintaining it. For this purpose it would seem that Unio "farming" might yet become desirable and practicable as a source of industry and of profit, more especially if carried on in connection with the insertion of figures, flags, and other forms that might find a ready sale.

Valve of unio in its natural state, and the same with "blanks" cut out from it. "Blanks" as cut; three upper figures showing inside, three lower showing outside with more or less of the epidermis. The same ground but not "centered" or polished. The same centered, i. e., with the central depression made, but not the holes. The same with the holes drilled complete. A dozen buttons, as fastened on card for sale.

THE EVOLUTION OF A PEARL BUTTON.

* From "The Fresh-Water Pearls and Pearl Fisheries of the United States." By G. F. Kunz. Issued by the United States Commission of Fish and Fisheries.

TECHNICAL EDUCATION OF THE DYER.

MUCH has been said and written regarding the problem of technical education in general, and especially so when it relates to that branch of work regarding the trades. At the present time there appear to be two opinions on this subject, one held by the workers in the several trades, and the other held by persons who, themselves, may not be skilled in any one art or trade, yet, by contact with artisans, learn that they are quite deficient in many of the more important underlying principles and who feel that it is the duty of the community to further the objects of technical instruction.

Several years ago a well known gentleman, then chemist in one of the largest iron works in Great Britain, in the preface to a very useful volume he had written on the subject of iron and steel, and commenting on the audience to whom he lectured, made up of the workmen of the plant, found that the four or five thousand men employed there could be divided into three classes, the first (and largest unfortunately) "neither knew, thought, nor cared anything about the scientific basis of their work; the second class treated 'the doctor's shop'—as they called the chemical laboratory—with contempt, and resented interference with their work. The third class had passed through both these stages of technological evolution, and were awakening to a perception of the fact that practical men, like themselves, might learn something from 'theorists,' a name they had recently learned to apply to all who made any pretensions to scientific attainments." This is not only the statement of the technical problem as it relates to the iron business, but in a more acute form is very prevalent in the dyeing and textile trades.

Formerly, a man who possessed a few formulæ, in some cases only one or two, was regarded as a very valuable man in a mill that had use only for the shades he produced, but to-day the conditions are very different, and competition has compelled and is daily forcing manufacturers to seek out only the best, most practical, and educated men for the positions in their mills. By education is not meant, necessarily, great proficiency in the ordinary branches of school education, but educated in the principles of their art. Of course, a man who has been to a school for a reasonable length of time, who can write, read, and hold his own in arithmetic, and who knows the details of the trade, be it what it may, is far better off than those whose only training and opportunities have been obtained in a dye house or print works, and whose stock in trade consists only of such recipes as they themselves compounded, without possessing to the slightest degree any knowledge as to why this or that was added.

Referring specially to the dyers' and printers' trade, there are many young men who have worked in it for a while, and who, hoping for further advancement in it, undertake to prepare themselves by taking up the study of chemistry, which is a very good move on their part; but, as they progress in this study, they find that there is but very little reference made to their trade, and consequently begin to lose interest, until, in despair, they give up and content themselves as best they can without the aid of this most necessary knowledge. Now, the question is, how can such men be made to realize that it is only by a thorough understanding of the principles of chemistry that they can know absolutely why this or that is added to a dye bath or pot of color, that it is added for a certain purpose, which must be known beforehand.

A dyer can place himself exactly in the position of a physician attending a case of sickness; he prescribes this and that, he must know first that both the drugs will mix, and that the effect is for a certain purpose; so with the dyer, he adds an acid of a certain kind for a certain purpose, and a certain salt the same; it is not at all sufficient for him to know that the "book says so," or that it is the way he "has always done." The actual work in a dye house, the mechanical handling of the materials to be dyed, is very simple, and any one, after being shown, can without much skill do it to satisfaction; but when the choice of dyes, salts, acids, etc., is to be made, then the thinking capacities of the foreman are called into play. It, then, is apparent that a knowledge of the properties of the several ingredients is of the utmost importance, and this knowledge can only be obtained by study. It is suggested to young dyers, men who feel the need of a greater knowledge of chemistry and physics, to commence the study of the science (the word science means "knowing how") from the beginning, and for the time being forget to

try to connect the study of general chemistry with dyeing, for after a while the two will connect themselves; do not attempt to study chemical analysis unless general chemistry is pretty thoroughly understood. This is a very interesting part, for, of course, every dyer wants to be able to find out for himself just what the composition of the substances he uses, but this requires a degree of experience to be obtained, rationally, after the elements. Of course, a dyer could, for example, take a "special course" in chemical analysis and be taught how to analyze acids, waters, soaps, etc., but if he were called on to explain this or that fact, his chemical knowledge would be lacking.

As a matter of fact, every dyer should be able, without any hesitancy on his part, to explain the properties and uses of every substance he uses, and if not to analyze them, be able at least to detect the impurities they contain, if any.

The instruction that technical schools should provide ought to have in view the ultimate needs of the students when they become journeymen, and so lay a foundation that will be secure. To attempt the training of dyers as such in schools has been a failure, but no student who has ever paid attention while at such an institution will say otherwise but that every bit of instruction he received was of a permanent value. The actual matching of colors must be gained under the guidance of a good dyer in a mill that handles several varieties of goods, for there only will a young man see the various operations of actual dyehouse management and control, and no technical school can teach it.—The Textile Record.

THE PRINCIPLES AND PRACTICE OF BULB-GROWING.

A VERY interesting and useful method, which is adopted in the propagation of the hyacinth, consists in making two or three longitudinal slits across the under side of the bulb, i. e., in the rudimentary stem after removal from the ground. When placed on the shelf to dry, it is not long before numbers of tiny young bulbs are formed at the margins of each slit. Another means employed for gaining from each bulb a much larger number of offspring than is produced by nature in the soil is that of scooping the bulb on the under side so that a large bowl-like cavity is formed, lined with the cut transverse surfaces of the fleshy

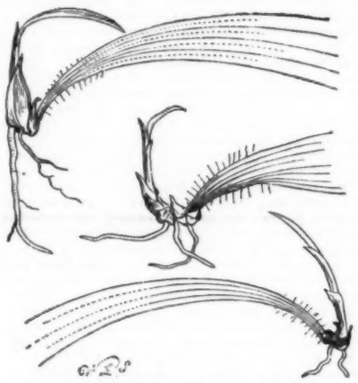


FIG. 1.—PLANT ARISING FROM A BUD ON LEAF OF CURCULIGO.

scales. At the margins of these surfaces sprout very numerous young bulbs of very small size representing so many tiny individual plants; these are all separated and grown apart in the autumn. It is well to study the raison d'etre and learn the biological significance of the production of young bulbs by these processes.

When a plant or part of a plant is wounded in any part of its tissues, it immediately sets to work to heal

FIG. 2.—METHOD OF NATURAL INCREASE OF BULBS IN NARCISSUS.

the wound which has been made; and this is effected by renewed growth on the part of the tissues immediately adjoining the injured part, so as eventually to cover over the wound by a protective callus. Some plants, but by no means all, have the power of producing, under certain conditions, offspring from nearly every organ, especially from the leaves; the instances of some ferns, begonia, curculigo (Fig. 1), streptocarpus, occur to us. If an incision be made in a detached leaf of a begonia lying on damp soil or sand, an entire new plant or plants will be formed at the margin of the incision. Numerous cases of natural adventitious budding will occur to us. This same power is possessed by bulbous plants. We have already seen how entire new individuals may be formed from ordinary branches of the stem in the ordinary natural method

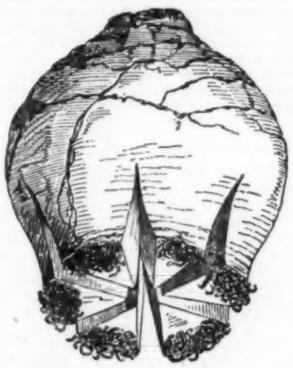


FIG. 3.—A METHOD OF HYACINTH PROPAGATION BY NOTCHING THE BASE OF THE BULB.

of bulb propagation (see illustration of narcissus, Fig. 2). That is a not uncommon phenomenon, for we know that very many plants have the power of forming new individuals from their branches or portions of their stems, as in cuttings. In the first-named slicing method of hyacinth propagation, it is the stem which is chiefly affected, hence we see here a case of adventitious budding from the stem of the same nature as the phenomenon of multiplication by means of cuttings. In the second-named method, however, that of "scooping" and "notching" (see Figs. 3 and 4), it is the foliar organs, the scales, equivalent to ordinary foliage leaves, which are affected, and hence we find here the same

FIG. 4.—A METHOD OF HYACINTH PROPAGATION BY SCOOPING OUT THE BASE OF THE BULB.

phenomenon of the production of new individuals from the leaf as in the begonia, for the tiny bulblets are formed all round the cut edges of the scales.

Now, in all these cases of adventitious budding, as the result of wounding in some way or other, the energy which in ordinary cases of wounding is used solely and simply for the healing of the injured part by the formation of the simple callus tissue is in those cases which we have had under consideration, as well as in others, directed toward the building up of a new individual, with all its complex, differentiated tissues. For these cases are generally those of fatal wounding of the plant or organ, in which the possibility of renewed life and growth is precluded forever. And then the instinct of the plant asserts itself in the endeavor to create a numerous progeny capable of continuing the thus violently interrupted life cycle—just as the

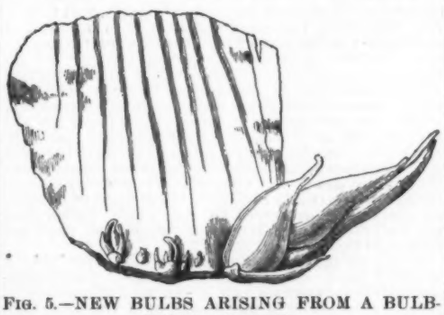


FIG. 5.—NEW BULBS ARISING FROM A BULB-SCALE OF LILY.

production of great quantities of spores is induced in many fungi and algæ when unfavorable outward conditions prevent a continuance of their normal vegetative growth. Very fortunate and convenient for the bulb grower is this habit of economy and desire for offspring on the part of the plant.

This same faculty in the plant of producing new individuals from the vegetative organs by adventitious budding is seen in some of the lilies (see Fig. 5). We used to propagate Lilium auratum, the beautiful Japan lily, in part, by pulling some of the bulbs to pieces and sowing the separate scales in sand, for each scale is capable of producing a new plant from its injured basal end, when thus detached and isolated from the bulb; offspring, in fact, a similar instance to that of the begonia and streptocarpus leaf, and compensating by this rejuvenated process for the entire destruction of the parent bulb.

The main reasons for the annual removal of the bulbs from the soil, and storing them until the planting season again recurs, are the following: The young bulbs can then be detached and sorted from the others; the bulbs are secured thereby from the dangers of mice, and from accident from rain or drought; the decaying or unhealthy scales and roots can be removed, allowing a freer circulation of air and freedom from infection by bacteria to the remaining parts of the bulb, and a longer rest and respite from growth is allowed to the bulb than they would get if left in the ground, and have a likelihood of their more profuse flowering next spring.

A method of cultivation of hyacinth bulbs familiar to every lover of flowers demonstrates clearly the nature and function of the "bulb" as the storehouse of all the food substances necessary for the production of the leaves and the flowers. This is the practice of growing the bulbs in glass vases of water so that the latter just bathes the base of the bulb, when long roots can be seen growing out and downward through the transparent liquid. The uninitiated will sometimes wonder, doubtless, how the bulb can thus throw up leaves and flower spikes without any soil around it, being acquainted with the fact that bulbs are usually grown under the garden mould. But to the interested grower who understands something of the common laws of plant life and the functions of the various organs of a plant before commencing the attempt of the successful cultivation of an organism like a bulbous plant, the case is fairly simple and easy of explanation. For the bulb contains within its own thick fleshy scales nearly all the nutriment necessary for the development of the aerial flowers and leaves, whose rudiments are already laid down within the heart of the bulb. The roots supply the water, which will also contain a few of the salts in solution which are needful for the growth of the flower and foliage. So far, however, and no further, can this pretty method of water culture proceed. For the permanent growth of the bulb under such conditions would be impossible; because the water, unless it were specially prepared for the purpose, cannot supply all the requisite salts so essential to the plant, which are found in the soil. If sufficient skill, labor, and patience were afforded, however, water culture would be quite possible, at least for a certain length of time as an interesting hobby and experiment; but for all practical purposes it would be useless and is quite contrary to nature.

In conclusion, I would say that bulbous plants, like other members of the vegetable kingdom, are to be treated under cultivation in accordance with their peculiar organization, structure, and habits, and I am convinced that the perfection of horticulture will alone be attained when an interested and familiar knowledge of the structure and life histories of plants is united to a thorough and practical acquaintance with their treatment in the garden under cultivation.—W. C. Worsdell, in Gardeners' Chronicle.

REPETITION AND EVOLUTION IN BIRD SONG.

By CHARLES A. WITCHELL.

THROUGHOUT the animal world we may find numberless instances of acts being rapidly repeated, with apparently only one sustained effort for the series, which acts seem to have originally been performed much less speedily and with separate efforts. Repetition means facility. Facility generally implies rapidity of repetition, and a series of acts for one purpose.

In the cries and songs of birds, we not only find indications of a former progressive evolution through the medium of mere repetition, but we may observe this evolution in actual development. I have elsewhere suggested that some prolonged alarms and songs of birds may be considered to have been evolved from mere repetitions of one cry. We may suppose that in some species a long song was a desideratum, since it is unaccompanied by any considerable variation in pitch. In the nightjar and grasshopper warbler there is practically no variation, though the latter "drums" in about the interval of a minor third.

The cricket-like chirp of the chiff-chaff may be heard everywhere, and is occasionally given in autumn as well as in spring; but I have never heard it rendered in more than three syllables, and it almost invariably consists of two only. It would be interesting to know whether readers of Knowledge have ever heard this uttered with four or five syllables. If such a local variation were discovered, it might be considered as a survival of an earlier form of cry, or as an advance upon the ordinary song. I incline to the former proposition.

The turtle dove has a tremulous purring note, reminding one of the croak of the common frog (not of the more commonly heard "work, work" of the toad). It seems to consist of a very rapid succession of little coos. If greatly prolonged, it would remind one of the note of the nightjar. In the common pigeon and some of the doves also, a succession of little coos constitutes the whole song, which is often somewhat elaborate—as in the common collared turtle dove.

There may, of course, be the change of retrogression or reversal, as well as changes due to elaboration. The great titmouse seems to afford an instance of the former. The young (out of the nest) have a repeated cry with a curious wryneck-like tone, which may be rendered "klee, klee, klee." It is generally repeated from three to five times. The old bird never repeats a cry of this tone, but it utters a long single note as a cry of distress when a hawk is in sight. The cry of the young is no doubt inherited, and it may seem that the note may formerly have been repeated often by adult birds where it is now given only in single long cries.

On the other hand, the adult great tit has an alarm (a rapid "shashashasha") which is absent from the

young. This is the most frequent danger signal of the old birds, and it always contains many syllables, all given, however, at the same pitch. How long it takes a wild titmouse to develop a variation of an alarm cry I know not, but in Western Canada I heard the marsh tits giving precisely the same note as their British prototypes, though the birds of the two countries must have been wholly separated during an incalculable period of time.

At Montreal, also, the house sparrows (which were said to have been introduced fifteen years earlier from the States, and not from England) had exactly the same cry, as well as the same manners, as the British bird. The sparrow, when bred in a cage, proves itself to have a strong tendency toward mimicry; yet these Canadian birds, like the marsh tits of the Far West, and the sparrows that chirp on the Bank of England, retained the ancestral tones of their species.

An interesting instance of repetition, developed in one strain to completeness, and in another not advanced beyond an elementary stage, occurs in the wood wren. This bird's song consists of the simple repetition of a not musical sound, slow at first, but gradually getting faster until the song ends in an ecstasy. The whole may be rendered "si-si-si-sisisisi." The pitch varies only a little; but there is a beautiful even accelerando in the strain. The bird has another cry which might be taken for a song, but this seems to be really a signal of danger. It is a full, brief whistle, repeated two or three times at the same pitch, and at about the rate of two per second. It may be written "kew, kew, kew." I have listened, but in vain, for any sign that even one of these birds had any inclination to repeat this beautiful note more than four times in succession. If that sound were somewhat prolonged, and given a few more times, it would rival some of the sweetest strains of the nightingale. But the wood wren neglects this pure tone and throws all his efforts into the sibilous strain which falls to us from the tree tops, even as it fell on the ear of Gilbert White long ago.

The cuckoo, like the wood wren, has developed the repetition of a note into a strain—a full toned bubbling cry, which is uttered at least by the female—yet the well known "cuckoo" is given with apparently no suggestion of a further development than the doubling of the first note.

The sedge warbler is much more inventive, for he frequently creates an original strain by associating two or three cries of other species, and repeating them in a certain order and with a definite accent many times successively in one song, thus proving what a single bird can do by means of repetition, and indicating what may be occurring much less quickly in other species.

In the thrush a few notes, often borrowed, are very generally repeated a few times, but never prolonged, as in the song of the sedge warbler. The thrush, indeed, seems to repeat from lack of originality, and yet without sufficient persistence to produce striking strains.

The nightingale is, however, the master of repetition in song. The majority of his strains simply consist of one or two notes repeated with varying speed, the whole song including from two or three to twenty-five or thirty repetitions of one note. I have counted as many as thirty-three repetitions, given at about the rate of five per second, and this number is probably often exceeded, though not after the middle of May, when the song begins to wane. The charm of the bird may be partly due to its repetitions, for the ear is not so tired by them as by the rapid, jerky songs of the blackcap and some other quick singers, but may dwell on and enjoy each simple pure tone. The nightingale has acquired a magnificent crescendo; and one cannot but surmise that human ideas of this grace in singing may have been borrowed from the bird. The sedge warbler and blackcap, and perhaps the wood wren also, have imperfectly acquired it.

The origin of some of the nightingale's strains may presumably be found in single cries—a history which, in the case of the well known long notes of the bird, is occasionally traversed at the present time. A little call note, "tewy," is sometimes produced several times in succession, each note more prolonged than the last, until the strain ends in the ordinary long notes in all their sweetness.

The origin of certain prolonged strains may also be indicated in the cries of young birds. The nightingale, for instance, has a harsh "sisisisisi" which is quite unlike its sweeter tones. The fledged young one, however, when being fed, utters a similar long rapid cry. The ordinary cry of the young is a croak similar to that of the parents.

The young greenfinch, ready to quit the nest, utters when being fed a rattling cry so like the "dididitit" rattle in the song of the parent that the only point of distinction is that the parent gives the strain in several keys, and interrupts it with other cries. The actual rattle is identical with that of the young.

The young fledged nuthatch, when being fed, utters a quick repetition of an almost toneless cry, with the same general character, however, as the full, bubbling song rattle of the adult.

It would, therefore, seem that when some song birds are developing their strains by simple repetitions of cries, they may be less inventive than at first appears, and be merely returning to an infantile mode of expressing a want.

The following note may be of interest as indicating that a bird whose habitat is remote from the range of our nightingale has followed a similar method in developing a song. The British birds have a rather short strain consisting of three or four peeting notes given at the same pitch, and an ensuing full rattling sound at a lower pitch, the whole sounding something like a "pee pee pee boblobloble." This is given throughout the season of song, though it is one of the least noticeable of the usual strains. It is varied in length of repetition very slightly, but is rendered in any interval of pitch between a third and an octave. Three years ago in Vancouver City I was much struck with the song of a common bush warbler, a bird with the general appearance and manners of our hedge sparrow. The bird gave this strain of our nightingale perfectly, except that the leading notes seemed to be very slightly inflected.

The strain was in all other respects the strain of our nightingale, pure and simple. It seemed never to be modulated by the Canadian bird; and it was particularly noticeable as being almost the only bird-song to be heard. But so frequent was it that the canaries on the houses near vacant lots had all caught the song, and included it in their own strains, and so accurately, that often I should not have known which bird was singing had not the sound come from some lofty window and not from the low bushes. I doubt not but that many of the canaries in Vancouver still have this strain, and that any local observer who has noticed the song of the warbler could confirm my statement as to the canaries. Did the Canadian bird borrow it from our nightingale or vice versa? Or did they, uninfluenced by each other, follow the same course in elaborating their strains from simple originals?—Knowledge.

THE DISEASES OF NATIONS.*

FOR some reason best known to your Lecture Committee, you have invited this evening to address you, a doctor of medicine; and it is rather well known that it is very hard for doctors of medicine to lecture on anything except medicine; and it is a medical lecture to which I invite your attention this evening. Then, again, the science of medicine, which I represent on this occasion, is divided into three divisions: the one considers pathology, that is to say, the nature and origin of diseases; the second considers therapeutics, the method of curing diseases; and the third takes for its development hygiene, the method of preventing diseases. I desire to say at the outset that I take only the first of these departments, that is to say, I shall study the nature and origin—causes—of diseases; but upon this occasion I shall confine myself to a branch of medicine comparatively little studied, although of singular and great importance—not any longer the diseases of men or women, of children or of any particular individual, but of nations, of the collective group of people whom we generally name as a nation. It may be a tribe, it may be a confederacy—name it what you will—it is the social group which I am going to study in its pathological relations; and I shall usually use the word nation for convenience, without going into any hair-splitting examination of differences between these social groups.

The nation has often been considered an organism: that is to say, it has been regarded as in very many respects similar to the single individual, and with justice, inasmuch as we cannot attack any department of a nation successfully without injuring the whole of the nation; nor can we greatly benefit any one element of a nation unless that benefit, to some extent, redounds to the benefit of the whole. Looking upon nations as organisms, those who have studied that subject have claimed that the nation, like the individual, has its life: it has its youth, its maturity and its period of decay; and these periods are laid down by some law of nature just as inflexible as that which controls the life of the individual. You all know that science has been importuned to stay the progress of time and the destruction of the individual. He is sure to pass through the varieties of periods; and when he has the best of fortune he meets, finally and surely, at a given time,-senility, decay, death.

A French officer, some half-century ago, made a very careful study of the natural life of nations. Supposing that a nation is not destroyed by an enemy, how long will that nation live? What, in other words, is the natural term of life of a nation? He places it between eight hundred and one thousand years; and supports his statement by a long series of historical investigations. I shall not, at present, discuss the accuracy of this statement of his; it certainly has been true in the past. There are some reasons I might give why it would not necessarily be true in the future. It is possible, we may entertain the hope, the belief, the confidence, that a nation, if it is thoroughly conscious of what it is doing, and is not crushed by some of those deadly blows which seem to be of fate, that it may guard itself against the approach of these national diseases and in such a way as to insure itself a life indefinitely prolonged. But such has not been the case in the past; and such, so far as we look around us, is not the case in the present.

What, then, are the diseases that militate against the life of nations? What, in fact, is the nature of a disease of nations? I wish to be very careful about this; and therefore I will read to you the definition that I would give of a national disease. It is when the nation, as a unit, is chronically incapable of directing its activities toward self-preservation. Now, such diseases which may bring about that result may not be of the majority of the nation, by any means. It is an important point for you to remember: it may be as it is in the human system. We, in the human system, may be perfectly healthy throughout all our economy: only one organ may fail us; but that one organ failing us may precipitate our untimely death, and that is very frequently the case; and so it is in nations. I could give you instances from history, were it necessary (but they will recur to your memory), where, for instance, a dissolute priesthood, where an aristocracy which had become degenerate, where a particular form of government which had become untrustworthy, led to the destruction of that nation; and yet the majority of that nation may have been perfectly healthy in their feelings, and they might have survived had it not been that this particular social element was thoroughly and utterly diseased. Therefore, I wish to be understood, when I speak of the diseases of nations, as speaking in reference to the whole nation—not upon all the individuals of that nation, but upon the national life.

When, in medicine, we take up this great branch which I have mentioned, of diseases, pathology—nosology we sometimes call it—we seek to discover, if possible, the causes of the disease, or of the pathological condition, which we find present. In a similar manner I invite you to consider the causes of a number of national diseases which have brought nations to destruction in the past, and which threaten to do so with many of them to-day. I have classified the main causes of diseases under four headings, to which I shall consecutively invite your attention. The first of these is imperfect nutrition; the second is poisons; the third is mental shock; and the fourth is sexual subversion. I begin, as I believe that any physician would begin, with distinctly physical, physiological causes. Do not delude yourselves with the idea that nations fall through some psychological cause always. All psychological causes, all diseases of the mind, from the point of view of the physician, are based upon diseases of the body. All sound physicians, when they discover a mental disease, seek for its physical—its physiological—basis; and that, and that alone, requires the attention of the physician in the first instance. Now I shall take up each one of those four causes of the diseases of nations by itself and give you some examples and explain to you how they apply to the question which is before us to-night. I will begin, for instance, with that one of imperfect nutrition. Some physicians say that all diseases whatsoever in the human body begin with insufficient, or misdirected, nutrition of one of the organs of the body. If this is the case for the physician, you see at once how eminently important it is that the nation should be sustained by proper food, in sufficient quantities and properly prepared: otherwise, it lays the foundation for those mental diseases which soon tell, with destructive results, upon the body politic.

The historian Buckle, a man of great genius, who was removed from the intellectual life of England in an untimely manner, uttered many admirable phrases in his work on the "History of Civilization." He often carried his ideas too far; but yet I must agree with him when he said that "the history of every nation could be traced by the food it was accustomed to eat." Of course, that expression is putting it somewhat too strongly. He was aiming rather to point an antithesis than to express fully a scientific theorem; but it is undoubtedly true that every nation must have, throughout all of the nation, enough to eat, of good quality and properly prepared, or that nation will degenerate. I need not tell you that starvation—I do not mean absolute lack of food but the insufficiency of food or the difficulty of obtaining food without an undue struggle for it—that that lies at the foundation of ever so many physical and mental degenerations in the human body and mind. When we come to look around us to-day, we see many sad sights in this very respect. I was speaking only yesterday to a prominent business man of this city who takes some slight interest in questions of this kind, and he put to me the inquiry why it was that, having food as cheap as we have it (as cheap as it is to be found anywhere in the world) and of good quality, there is yet, he assured me, many and many an instance of practical starvation, even in this city of ours and throughout our country: it is of no importance, as he argued, that potatoes may be bought at 12 cents a bushel if you have not got the 12 cents to buy them with; and it is the same everywhere.

What is the condition to-day of the nations in Europe? There is scarcely a nation in Europe which has enough to eat—I mean which raises enough to eat. England, whom we look upon as one of the most prosperous nations of the world, depends for two-thirds (very nearly) of all the food that it eats, not upon itself, but upon other and distant and possible unfriendly nations. Were the supply of food stopped in England to-day, in less than one month thousands of people would be dying of starvation in the streets of London and in three months the number might be millions. The fact that there would be no food—not enough—that is a most dangerous condition for any nation to be in. It is really insufficiency of food that is threatening the nations of Europe; and they make the most strenuous efforts toward the protection of their agriculture in consequence of it. They are perfectly well aware that this dreadful disease, foundation of all diseases—starvation—is going to be their terrible enemy in time of general warfare. It is that consideration, more than anything else, that binds them to an unwilling peace. Writers who have witnessed something of the painful struggles of the poor in this and other cities in order to supply themselves with the necessaries of life as we call it feel keenly how much the insufficiency of food brings with it of misery and wretchedness. What is freedom? Said Dr. Johnson: "Freedom to the Englishman is the right to work or to starve;" and it is starvation which is in front of every nation to-day.

The actual effect of limited food for a long time has been carefully studied by physicians from the point of view of national economy. We can see and distinctly point out the results of a prolonged absence of food on many nations. We know that it brings about degeneration of tissue, inferiority of stature, weakening of the body, and in all other respects making them physically and mentally incapable of aiding the great work of the progress of civilization. Nothing, therefore, can be more dreadful than the prospect of national starvation, even in the limited sense of the word. I shall speak of unsuitable food, but in a very few words. A striking example of it is found in the northern part of Italy. In Northern Italy you will find a country blessed by nature with every element of fertility, yet the people of that country presenting aspects of physical degradation. They have a disease (known almost only there) that is brought about by the character of the food they eat. They eat the maize (what we call Indian corn) when it is (as it often is in that country) blighted by a kind of ergot. The result of that is a special disease which weakens the body and weakens also the mind. Wherever you find a nation decidedly below the average stature, you may be sure that that nation has passed through a period of insufficient, or unsuitable, food. The Jews of Europe, to-day, are about three to two inches (three inches in the males and two in the females) underneath the average stature of the nations with whom they live and have lived since the middle ages. The cause of that is unquestionably that their food has been too limited in character and insufficient in quality and amount; and that is recognized as the one reason of their inferior physical power. The Lapps of Northern Europe, the inhabitants of the Cevennes and Ardennes, and the Bushmen, all these are people who have been starving for generations, and they have been reduced from the average stature of 5 feet 8 inches to 4 feet 10 or 11 or 12 (not above 5 feet). They come into that unfortunate inheritage through insufficient food; and I might say somewhat in reference to the fact of the improper preparation of food. I consider that one of the causes of many diseases of our nation is the fact that cookery is not good in the United

* A lecture delivered October 28, 1898, at Mercantile Library Hall, Philadelphia, by Dr. Daniel G. Brinton, of the University of Pennsylvania, before the Society of Ethical Research. Prepared especially for the SCIENTIFIC AMERICAN SUPPLEMENT.

States. If you do not believe me, take a trip through the Southwest, and you will readily be convinced that the people down there are wretched and miserable in health, chiefly through the fact that their food (which is sufficiently abundant) is prepared in a manner calculated to destroy the integrity of the digestive tract almost surely.

I shall, therefore, proceed to consider my second section—poisons. A French writer of eminence, who has written long and lengthily on the subject on which I am lecturing, has stated that there is no more potent element of degeneration now active among nations than one. I don't know whether you would guess it, but I was speaking to one or two gentlemen since I came into the room about it; they seemed to have observed it. I mean alcohol. The use of alcohol to a limited extent might, indeed, be harmless, may be beneficial; but the using it as it is now customary in most nations—and those nations often among the most civilized—there can be no doubt brings with it the elements of national degeneration and decay. I do not believe that any physician who has looked at the matter absolutely without bias could arise and deny it. I speak of this without any prejudice. I am a man who takes a drink occasionally and in a public place and has no hesitation in doing it; and I should be very sorry to be a Prohibitionist; yet I do not, on that account, allow myself for a moment to be influenced into the belief that alcohol, used to the extent that it is used, is anything less than an element of national decay. It means the production of a disease of the nations; and so there are many other narcotics and stimulants which have the same effect. I may mention the use of café (which is used among the Arabic population of the Sahara and elsewhere) and of coca (which was found so destructive that even the Spaniards, who did not look very carefully after the welfare of their people, prohibited the use of it in Peru and the adjacent parts of South America); and I am not afraid, also, to add to that tobacco, which I consider also to be a distinct element of national degeneration. A nation of smokers will, undoubtedly, be weaker, mentally and physically, than a nation of non-smokers; and I smoke. Therefore, I speak freely on that subject; but I cannot deny the facts which I see before me and recognize.

These are poisons which we deliberately and intentionally take into ourselves, knowing the results; at least, we ought to know them and we ought not to shut our eyes to them. We take the chances on that; but there are a number of other poisons, distinctly influencing national power, which, up to the present time, medical science has not been able to meet—malaria, for instance. There are vast districts of the earth's surface which are so permeated with the malarial poison that no race can be there and reach a high degree of physical and mental power. If you have not looked up the subject, you would be surprised to find what vast areas of the earth's surface are afflicted in this manner. There are areas probably as great as the whole of Europe twice over where it will be (as far as we see) absolutely impossible for any nation to survive and prosper. Men live there—they live everywhere; but they are not in a condition ever to assist much in the great march of progress; and wherever malaria is constantly and persistently prevalent, you need not expect that that nation, if it is limited to that area, will ever count for much in the history of mankind. That were impossible. There are, however, others; there is the affliction of water, which is limited in area, and there is cretinism, and there are a series of infectious diseases which often become extremely prevalent, such as leprosy and syphilis—poisons which are propagated and which may become tribal or national, and have become so within the period of human history, destroying the physical, and with it reducing the mental, power of any tribe or nation, city or government, which is largely exposed to them. These are purely physical diseases; but they are national in their character. They influence, distinctly and positively, and without any doubt at all, the history of the nation; shorten its life; destroy its power.

I shall speak something of the peculiar physical effect which medical men call "shock." Sometimes, in performing a surgical operation, the surgeon knows perfectly well that the operation will be successful under ordinary conditions; and yet he is aware that certain mental temperaments have received what we call "surgical shock" by that operation, which imperils, if it does not destroy, life, which, otherwise, under ordinary conditions, would be saved. There is something of the same kind in the history of nations. They, too, are subject to have that mental shock which seems to overbalance them. They do not any longer have control over their faculties. They yield to despair and in consequence fail. I will give you two very well-known examples to all who have studied early American history. Cortez, with a few hundred soldiers, and thirteen hundred horses only, landed where Vera Cruz is now situated, and attacked a nation which could control and put in the field certainly a hundred thousand trained warriors. He attacked it and conquered it; but it was through a mental shock which really disabled those Aztec Indians from opposing him. They found themselves under such new conditions, meeting enemies who seemed to possess the very lightning and thunder of heaven in their arquebuses, that they felt themselves wholly incapable to fight as they had been accustomed to fight. So Pizarro—a rude, unlettered pirate, landing on the shore of South America, and burning his ships behind him—entered the ancient and powerful empire of Peru, which stretched itself, without a break, for fifteen hundred miles along the coast of South America and far into the interior, and which, by its power, had conquered all the nations within that large area; and yet it fell before him like a house of cards. They had, somehow, the same shock; and I have been told by travelers and investigators who have recently been among the Indians of South America, that wherever they (the Indians) have met the Spaniards, they have felt themselves at once yield to their power, unable to cope with them, unwilling, apparently, to draw from their own resources of strength against them.

Another element of shock comes into any national catastrophe; there are many national catastrophes in history which I can mention. Let me take one of a different kind. When the "black death" struck Europe in the XIV. century, it swept away, out of the population of Europe, over one-half; at any rate, it is estimated, in medical annals, that 24,000,000 people died of that very disease which, within the last few days, has started in Vienna and called by us now the "bubonic plague" (then called the "black death"). The shock was so great upon the nations of Europe that their armies melted away, they did not dare to have an army; the moment an army was gathered together, the plague would break out and would sweep it into nothingness. The nations were in such a condition that had they then been attacked by any nation free from the insidious destructiveness of this disease, they would all have yielded. It was a mental rather than a physical shock. They felt themselves unable to cope with what was called "the judgment."

Now I shall take my fourth element of disease; it is one about which I shall have some difficulty in speaking in detail before a popular audience (it would be much better spoken before a selected audience, or in the halls of a medical college): that is sexual subversion; and yet I regard it as probably the most important cause—the most insidious, prolonged and dangerous of all the causes of national disease. I shall, however, lay before you the principal headings under which this difficult subject should be treated—treated in the detail which, however, at present I shall not attempt. Every nation, let me say, to begin with, if it is to be prosperous, if it is not going to retrograde and degenerate, must increase in numbers; and it must increase not through immigration only but also through natural reproduction; and you may as well lay it down as a fundamental principle, proved by all history, not merely that parents shall produce children to the number that they are themselves; because statistics, carefully worked up, have shown that every married pair (allowing that every male and female in a country marries)—that every married pair must produce at least four children, that the total population does not retrograde, merely to keep it even. That is based on the statistics of millions of people in this country and in Europe. I could show you why; because infant mortality carries off always at least one-fourth of the population; so that four becomes three, and then there is always a proportion of infertility and sterility on both sides, which prevent marriages having any children; and then again there is the early death, in marriage, of the wife or the husband; and for all these reasons statistics show that in round numbers (not going into fractions) every person in a nation, were they to marry and were each couple to have four children, the nation would merely be even—that would be all. Therefore, fertility, reproduction, natural reproduction, without taking into account immigration, in the long run must be looked after in every nation if it is not going to fall into decay.

Now that is not the case with a great many nations. Those statistics do not hold good of, for instance, France, nor of New England. The commonwealth of Massachusetts you may compare with many of the prefectures of Central France, and you will find that statistics prove that in both those areas there is a distinct diminution of the population, if you count out immigration. They would be decaying wildernesses today, and the farms would be abandoned and the houses shut up, were it not for the immigration. Why? Because (for some reason, it is needless for me to go into them, they are multiple) marriage does not take place, or, if it does take place, marriage is comparatively infertile. It does not reach the necessary number of children to keep the population up to the mark. That is the fundamental principle of national progress. We are getting along very well, in spite of these statistics from Massachusetts, because they do not extend to other portions of the country; and, also, because we are receiving, constantly pouring into our shores from all directions, immigrants from other countries.

That is one of the laws. In accordance with that a nation is sure to become diseased when for any reason (religious or secular) there is a large abstention from marriage. Mr. Galton, one of the best statisticians of England, has written a work on this subject of the "Influence of Celibacy and Spinsterhood on the Fate of Nations." He has pointed out that the celibacy which has been enjoined by Christianity—the celibacy of the priesthood and the conventual life—which was so long urged and is yet by several of the leading sects of Christianity, has resulted distinctly in national decay; that they have always selected the best men and the best women for the celibate life, and the result of that is that the latter have not had the possibility of passing down their superior faculties to other generations. He points out, therefore, with an argument that cannot be denied, that the whole of the doctrine of celibacy—of the conventual life—on whatever ground (not always religious) is fatal to a nation's prosperity.

There are, though not among civilized nations, various abnormal forms of marriage which have the same result. You might not be interested in them because they do not touch our own constitutional life; yet the ethnologist and the anthropologist look upon them with a great deal of curiosity and interest; as, for instance, where a man has many wives, or a woman has many husbands, recognized forms of marriage which exist in the various lower tribes and nations; but I shall pass them by. I think we are interested, rather, in what concerns great nations than in the past. The limitation of births is one of extreme importance, as I have shown in this country and in France. It is also common elsewhere: in the island of Formosa (lately obtained by Japan) it has been always, from time immemorial, a discredit to a woman to have a child before she is thirty-five years of age—at least, to have a child which she raises. Infanticide, therefore, is very common, as it is in China; and the distinct preference for infanticide over rearing the children is there, and in China, and is everywhere a prevailing disease of the national life which brings it, as it has brought those nations, into subjection and ruin.

There is another branch of the subject which I may refer to in passing: sexual inversion, it is sometimes called; or the irregular and illegal and unnatural tendency of the sexual instinct in its satisfactions. I can only mention this. It would not be pleasant to you to have me go into details on such a subject as this. If I mention it, it is enough, because I am sure you will all agree that a tendency of that kind, widely prevalent in a nation, will unquestionably lead to one of those diseases of national life which will invalidate its powers.

But there is an allied subject which is of the greatest importance and has been recently brought forward by an Italian writer with singular ability in a study of the relative present condition of what we call the Latin races and the Teutonic races. You know the Latin peoples or races—France, Italy, Spain—have not been getting along so well as the Teutonic races represented by Germany, England and the United States. This brilliant Italian writer (himself belonging to the Latin peoples) asks himself (and explains to the world what he considers the answer) the cause of this gradual inferiority—growing inferiority—of the Latin peoples within the last two centuries; because two hundred years ago they were distinctly in advance, nationally, of any of the nations of the Teutonic peoples. He traces it with a great deal of brilliancy and acumen to one peculiarity which runs through the whole of the Latin people; and that is the predominance of the sexual sentiment. He says that a man, a Frenchman or an Italian, will spend a great portion of his life in thinking on the other sex and in trying to satisfy his wishes and his amours with them; he is governed by love of diversity; but he says a German or an Englishman will occupy his mind with other things—he will be thinking of his business; he will be thinking of his studies; he will be working in his profession or his occupation; and his mind will not be occupied with that other thought anything like to the same extent that an Italian or a Frenchman would be occupied with it. "Hence," he says, "these Germans and Englishmen, they get ahead of us on that account. They are constantly working for that which makes constantly for national power through individual prosperity, but we are thinking of our pleasures. We are thinking of pleasing the other sex, not merely those with whom we are legally bound, but in a general way;" and he attributes to that, more than to anything else, the failure of the Latin peoples within this century. He acknowledges the failure—I think we all acknowledge it; but that is his explanation of it.

I have given you, in these four headings, the principal causes of national disease. I am going now to ask your attention, following out the medical line which I have laid before myself, to the diseases of the national mind. I have been treating heretofore the diseases of the national body, more particularly those diseases which affect the physical powers. Now there are a large number of national diseases, and I must run over them with some brevity. We doctors, in studying diseases of the mind, divide them into two great classes. All alienists (as we call them) do this. One is diseases of the emotions; and the other, diseases of the intellect. That is the practical, usual medical division; and I will follow it in treating the diseases of the national intellect and national emotion, and I will begin with the national intellect. I need hardly speak of imbecility as belonging to a nation. It does belong to many tribes—lower tribes—such as the Australians. They are really incapable of following out a logical argument as a mass. They are, therefore, at a great disadvantage when they meet with civilization. They do not know what to make of it, they cannot understand it, it cannot be explained to them, the result of it is they die—they become exterminated. It is not the fault of the white man altogether. They are simply incapable of accepting the explanation, and they meet the sad results; and yet it is very common among all nations, as they say, an incapacity of judging of evidence. I see, in this audience before me, several distinguished members of the bar, and I am very sure they would support me in the statement that they constantly meet with people, put on the witness stand or put in the jury box, who seem incapable of judging evidence. They cannot understand, these people cannot, the difference between a proof and merely a statement. They do not judge and they cannot judge of evidence as these gentlemen themselves could judge of it, perfectly clearly, and know it should be judged according to the laws of reason and logic. That is frequently national, and when it becomes national, it is a dangerous, and sometimes a fatal disease.

So criminality; where there is a large criminality in a community, it is a distinct sign of national disease. I am quite well aware that some one is ever ready to say, "But what is criminality? Who is the criminal?" The criminal is the man who, for selfish aims, would destroy the social existence around him, the social fabric about him—for selfish aims! I am quite well aware that that excludes a great many noble people who have been executed as criminals, and I intend it shall; but the man who, for selfish ends, would destroy the fabric of civilization and humanity which has been reared by generations, he is a criminal and no one can deny it. It may be that society creates the criminal—very likely; it may be a matter of heredity—very likely; that is a matter only of the cause of the disease. The disease is there. A largely criminal population, with its intentions to destroy society around it, for its own base purposes—that is a disease of the nations, and is sure to bring it into terrible straits.

Then there are, again, national delusions. It is very singular how a crowd of any kind can be swept, as by a tornado, with some delusion, with some notion that seizes it, affecting it physically and mentally, destroying its power of sound, logical reasoning, willing to follow the first leader who shouts for it to come. Many, indeed, are the instances in history where these delusions have led nations into great peril, or into ultimate destruction. There are delusions which are religious in character; there are nations who have gone to wreck and ruin because they have trusted in omens, because they believed that the divinity was leading them—a wild, fanatical delusion; just as we saw within a few months the delusion which led the Khalifa to destruction—all his beautiful army of 30,000 men marching out to meet the English, going forth on to the plain to fight with that delusion of faith that they would conquer; when, if they had staid behind their walls, they might, indeed, have conquered; but they were led to destruction by a fanatical and a religious delusion. Your memory will bring to your mind many such instances; and so the delusion of philosophy—really, what has brought into and under the power of England such myriads of human beings, so that with 50,000 men she controls 50,000,000, is the delusion of philosophy. All throughout the philosophies of India you find one dangerous delusion at the bottom of every one of them—their religion and their philosophy. It is a subtle thing, a curious compound. They do not be-

lieve in the reality of this existence; they believe that the higher reality is the subjective, not the objective; and owing to that they are paralyzed when they are called upon to take any serious and united action in the present, objective, world. It is what they themselves call the "Molya," the delusion; all this existence, this life, our own actions day by day, to their philosophers and to their preachers and teachers is a delusion. The English do not think so (laughter); they seem to have got the better of the bargain.

Again, dominant ideas—it is strange, indeed, how dominant ideas have constantly led nations on in certain lines, often to their peril, not infrequently to their death. They will have the idea of conquest, and they will go forth in order to seek conquest and will meet with defeat. They will have the idea of art, as did ancient Greece, giving up all else to that art; but, in the meanwhile, the Romans were preparing their arms, sharpening their swords, and Greece fell before Rome. So it is constantly, throughout the history of nations; when you look to what led a nation to its fall, you will frequently find that it possessed, that the minds of the leading men of the nation were possessed with, some ideal which was not in time, which did not belong to that day and date; and the result of it was, that they failed.

These are intellectual diseases of nations. I can speak also of a number of national emotions—such, for instance (and I will run over the headings very rapidly), as nervous excitability, emotional excitability—epidemic hysteria, we may call it. It was seen remarkably, the most wonderful example of any age, possibly, in the Crusades. The whole of Europe was seized with an emotional hysteria. Children, six, eight, nine years old, went forth, making children's crusades and extending over two centuries. They went alone, unattended except by those of their own age. Did their parents try to keep them at home, they refused food and died. They were seized with this powerful hysteria, the idea of carrying the banner of the cross into the lands of the crescent. So, also, the whole of the nations of Europe were seized with it likewise. You may get some idea of the result of it when I tell you the statistics show that in various cities and in many country districts, when the crusade was at its height, there was only one male left to seven females. So mental exaltation and mental depression—mental exaltation is a very common disease nowadays. It is sometimes called Jingoism; it is sometimes called by the French Chauvinism, from a certain soldier of Napoleon—the principal character of Scribe's "Soldat Laboreur," which a very prominent man afterward put on the stage. He was always saying, "Oh! if the emperor were here, he would do" this and that; and everything was for the emperor. So the jingo or the Chauvin always believes that it is his country, and his country alone, that is going to carry the banner in the vanguard of civilization and progress. He looks with pitying contempt on all other countries; makes no difference whether he is a scientific man working among microbes, or the warrior carrying his banner, or the commercial man sending out his drummers to the world, he knows that the nation which he represents is going to be boss of the world. I may name almost any of the leading nations of the day. Of course our own may be excepted (we are modest), but the other nations have no modesty on this subject at all. However, you can see that a nation that has its head developed to that extent would be very likely to get it knocked in sooner or later, and that has been the case with many and many a nation. Just to the extent that it considers that it knows it all, it does not care to learn from any other nation; and by so doing, it misses a great deal of the best that is to be discovered and learned. The result of that is a national disease of the emotions and may prove, as in the past, very fatal.

National depression is another. There are nations (there again, I don't believe we belong among them) who think so lightly of themselves that they do not feel themselves equal to any other going. They may see other nations walking around with a chip on their shoulder; but they know very well that they dare not touch that chip. There have been many such nations. There is a touching story given by Symonds of a nation which archæologists know as Greater Greece, in Southern Italy. After they had been to some extent conquered by Rome, they seemed to give up entirely; and once in every year they met in their temples, and expressed their grief with cries of sadness to their gods on the perfect hopelessness of any redemption. That very fact, that they were hopeless, led them soon to become absolutely extinct; so that the Grecian there was driven from the peninsula, and only the remains of his art were left to attest the presence of those great conquerors and teachers. So the fatalism of the Orient and the natural cowardice of the Chinese arise, in a certain sense, from national depression.

Now I have given you a very brief outline of the diseases of nations. I have, as you will observe, carefully abstained from trenching on either of my other divisions, the therapeutics or the hygiene of this subject. I am well aware that they offer very large fields for investigation, and I scarcely doubt but that there are a dozen or two persons in this audience who have in their vest pockets a recipe for all of the diseases which I have named; but I would ask it, as a favor (could I be favored or obliged with any discussion of this subject), that they will keep their recipes in their pockets—not bring up any such thing as tariff, free trade, or single tax, or anything of that kind, because I am not talking about cures, but only about diseases, and with that, thanking you for your attention, I vacate the platform.

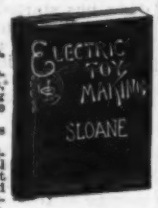
An Aseptic Filter.—For the aseptic filtration of water, A. Pannetier (Pharmaceutische Centralhalle) has constructed a filter of silica and manganese peroxide, possessing the following arrangement: The water first passes through two bags of close manila fabric, of which the first is filled with silica, the second with a mixture of coal and manganese. The cleansing of the filters is accomplished, without having to take them apart, by causing a solution of 2 grammes of potassium permanganate in 2 liters of water (for a filter holding 5 liters) to slowly drip through, until the liquid runs off red. The permanganate is then pushed out by water, whereupon the filtration proceeds as profusely and quickly as in the beginning.

ELECTRIC TOY MAKING.

DYNAMO BUILDING AND ELECTRIC MOTOR CONSTRUCTION.

BY PROF. T. O'CONOR SLOANE.

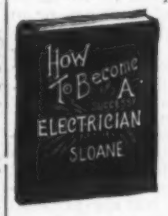
140 Pages, Very Fully Illustrated, Price $1.00.



This work treats of the making at home of electrical toys, electrical apparatus, motors, dynamos, and instruments in general, and is designed to bring within the reach of young and old the manufacture of genuine and useful electrical appliances.

The work is especially designed for amateurs and young folks.

Thousands of our young people are daily experimenting, and busily engaged in making electrical toys and apparatus of various kinds. The present work is just what is wanted to give the much needed information in a plain, practical manner, with illustrations to make easy the carrying out of the work.



How to Become a Successful Electrician.

BY PROF. T. O'CONOR SLOANE.

189 Pages, Illustrated, $1.00.

It is the ambition of thousands of young and old to become electrical engineers. Not every one is prepared to spend several thousand dollars upon a college course, even if the three or four years requisite are at their disposal. It is possible to become an electrical engineer without this sacrifice, and this work is designed to tell "How to Become a Successful Electrician," without the outlay usually spent in acquiring the profession.

Electricity Simplified.

BY PROF. T. O'CONOR SLOANE.

158 Pages, Fully Illustrated, Price, $1.00.

This work is the simplest ever published on the subject. Electricity is in many respects unexplained by the scientist; to the ordinary man it is all a mystery. This book makes the subject as plain as possible. Shows how two plates of different metals immersed in acid can send a message around the globe; how a bundle of copper wire rotated by a steam engine can be the agent in lighting our homes and streets, etc. By illustrations of original design and scope, the subject is made exceedingly simple.

1898 EDITION.

EXPERIMENTAL SCIENCE.

By GEO. M. HOPKINS.

Twentieth Edition, Revised and Enlarged. 914 Pages. 820 Illustrations. Elegantly bound in Cloth. Price, by mail, postpaid, $4.00; Half Morocco, $5.00.

This is a book full of interest and value for teachers, students and others who desire to impart or obtain a practical knowledge of Physics.

This splendid work gives young and old something worthy of thought. It has influenced thousands of men in the choice of a career. It will give anyone, young or old, information that will enable him to comprehend the great improvements of the day. It furnishes suggestions for hours of instructive recreation.

What the Press says of "Experimental Science."

"Mr. Hopkins has rendered a valuable service to experimental physics."—*Evening Post.*

"The book is one of very practical character, and no one of a scientific turn of mind could fail to find in its pages a fund of valuable information."—*Electric Age.*

"The work bears the stamp of a writer who writes nothing but with certainty of action and result, and of a teacher who imparts scientific information in an attractive and fascinating manner."—*American Engineer.*

"It should be found in every library."—*English Mechanic.*

"The book would be a most judicious holiday gift."—*Engineering and Mining Journal.*

Mr. Thomas A. Edison says: "The practical character of the physical apparatus, the clearness of the descriptive matter, and its entire freedom from mathematics, give the work a value in my mind superior to any other work on elementary physics of which I am aware."

Prof. D. W. Hering, University of the City of New York, says: "I know of no work that is at the same time so popular in style and so scientific in character."

Prof. W. J. Rolfe, of Cambridgeport, Mass., writes: "The book is by far the best thing of the kind I have seen, and I can commend it most cordially and emphatically."

Hundreds of cordial recommendations from eminent Professors and Scientific men.

Send for Illustrated Circular and Table of Contents.

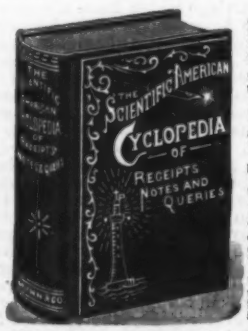
THE SCIENTIFIC AMERICAN

CYCLOPEDIA of RECEIPTS, NOTES and QUERIES

EDITED BY **ALBERT A. HOPKINS.**

12,500 Receipts, 708 Pages.

Price, $5 in cloth; $6 in sheep; $6.50 in half morocco; Postpaid



This splendid work contains a careful compilation of the most useful Receipts and Replies given in the Notes and Queries of correspondents as published in the SCIENTIFIC AMERICAN during the past fifty years; together with many valuable and important additions.

Over twelve thousand selected receipts are here collected; nearly every branch of the useful arts being represented. It is by far the most comprehensive volume of the kind ever placed before the public.

The work may be regarded as the product of the studies and practical experience of the ablest chemists and workers in all parts of the world; the information given being of the highest value, arranged and condensed in concise form, convenient for ready use.

Almost every inquiry that can be thought of, relating to formulæ used in the various manufacturing industries, will here be found answered.

Those who are in search of independent business or employment, relating to the home manufacture of salable articles, will find in it hundreds of most excellent suggestions.

Our large Catalogue of American and Foreign Scientific and Technical Books, embracing more than Fifty different subjects, and containing 116 pages, will be mailed, free, to any address in the world.

Any of the foregoing Books mailed, on receipt of price, to any address. Remit by Draft, Postal Note, Check, or Money Order, to order of

MUNN & CO.,
361 BROADWAY, NEW YORK.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to bookseilers, news agents, and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.

PAGE

I. ARCHITECTURE.—Archæological Museums.—Modes of Lighting.—Effect of Glass Upon Light..... 19283
New Building of the Union of Austrian Artists.—1 illustration. 19287

II. BOTANY.—The Principles and Practice of Bulb Growing.—5 illustrations..... 19291

III. CHEMISTRY.—Acetylene.—By Prof. LEWES.—An interesting article giving all the latest information on the properties of this gas..... 19289

IV. ELECTRICITY.—Some Interesting Electric Motors.—7 illustrations..... 19282
Electrical Work Done for Sampson's Fleet by the "Vulcan"... 19284

V. ETHNOLOGY.—The Diseases of Nations.—An elaborate study of the physical and psychological causes which affect the character of the people..... 19282
Khirgisian and Tartar Caravans in Germany.—4 illustrations.... 19286

VI. GEOLOGY.—Eleventh Winter Meeting of the Geological Society of America.—By E. O. HOVEY..... 19288

VII. MANUFACTURES.—Utilization of Unio Shells for Buttons.—1 illustration..... 19290

VIII. METEOROLOGY.—Almanacs and the Weather Bureau..... 19279
The British Weather Bureau..... 19280

IX. MISCELLANEOUS.—American Salesmen in Europe..... 19283
Cut Versus Wire Nails..... 19284
Electrical Notes..... 19285
Engineering Notes..... 19285
Selected Formulæ..... 19285
Test of the Gatling Cast Steel 8-inch Gun..... 19284
Testing Wind Forces..... 19284
The Dowager Empress of China.—Portrait..... 19279
The Thumb or Finger Tip Print as a Test of Identity..... 19281
Wooden Boxes for Coal in England..... 19287

X. NATURAL HISTORY.—Repetition and Evolution in Bird Song 19291

XI. TECHNOLOGY.—Technical Education of the Dyer..... 19290

XII. TRANSPORTATION.—French High Speed Compound Locomotives.—3 illustrations..... 19283

SPECIAL NAVAL SUPPLEMENT No. 1165

contains a historical review of the modern United States navy, the classification of the various forms of war vessels and nearly one hundred illustrations, including details of construction of such vessels not found in any other publication. A map of Cuba printed in five colors accompanies it. Price, 25 cents. Single copies sent by mail in United States, Canada and Mexico. Foreign countries, 8 cents extra.

MUNN & CO., 361 Broadway, New York.

THE SCIENTIFIC AMERICAN

Army and Coast Defence Supplement

It treats of guns and gun carriages for Army and Navy use and Coast Defence, including disappearing gun carriages, rapid fire guns, machine guns, mortars, etc., with special reference to their construction and operation. The subject of projectiles, powders, gun cotton, etc., is also fully treated; range finders, torpedoes, submarine mines and armor are all fully described and illustrated. There is also a section devoted to the small arms of the Army and Navy, together with an account of the organization of the Army, with fine engravings of prominent Generals. Never before have these subjects been treated in such a popular way. The illustrations number over 100 and include a magnificent double page Supplement of our largest battleship, the "Iowa." The whole is enclosed in a handsome cover, showing a large coast defence gun in action.

Price by mail, 25 cents; to foreign countries, 35 cents.

MUNN & CO., Publishers, 361 Broadway, New York.

BUILDING EDITION

OF THE

SCIENTIFIC AMERICAN.

Those who contemplate building should not fail to subscribe.

ONLY $2.50 A YEAR.

Semi-annual bound volumes $2.00 each, yearly bound volumes $3.50 each, prepaid by mail.

Each number contains elevations and plans of a variety of country houses; also a handsome

COLORED PLATE.

SINGLE COPIES, - - - - 25 CENTS EACH.

MUNN & CO., 361 Broadway, New York.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had over fifty years' experience, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Trade Marks, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent *free of charge*, on application, containing full information about Patents and how to procure them; directions concerning Trade Marks, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases, Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws, showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York

BRANCH OFFICES.—No. 625 F Street, Washington, D. C.